W. C. Jamison M.D.

THE

SURGERY OF THE CHEST.

THE

SURGERY OF THE CHEST.

BY

STEPHEN PAGET, M.A. Oxon., F.R.C.S.,

SURGEON TO THE WEST LONDON HOSPITAL, AND TO THE METROPOLITAN HOSPITAL.

ILLUSTRATED.

BRISTOL: JOHN WRIGHT & CO.

LONDON: SIMPKIN, MARSHALL, HAMILTON, KENT & Co., LTD.

1896.

JOHN WRIGHT AND CO.,
PRINTERS AND PUBLISHERS, BRISTOL.

MAGISTRIS MEIS OMNIBUS

PRIMO PRÆSERTIM OMNIUM ET SUMMO

PATRI DILECTISSIMO

IMO DE PECTORE

REFERO GRATIAS LIBELLUM DEDICO.

PREFACE.

FROM time to time I have published notes on cases illustrating the Surgery of the Chest, and in this way I was led to study the accumulated records of it. During the last five and twenty years, thanks to Lister, it has advanced with wonderful rapidity: and there has been an equally rapid increase of the literature relating to it, both in this country and abroad.

Concerning one most important part of my subject, the Diseases of the Lungs and Pleuræ, we shall before long have a work written in part by Mr. Godlee, the pioneer of English surgeons in this great field of practice. But hitherto no attempt has been made in England to put together a book on the whole subject of the Surgery of the Chest, both in injury and in disease.

Now is the time when such a book can hardly fail to be useful: first, because there is a vast store of good material to be worked into it; next, because there are signs that we have reached a stage, in this portion of our art, beyond which, on our present lines, we cannot advance much further.

However this may be, I have tried to state the

case for Surgery, as it now stands, clearly and fairly: and to present, from a wealth of scattered writings, those rules which are most likely to help the surgeon in the difficulties of practice. Reading the literature of this great field of Surgery, I have often found myself wandering off the main road down pleasant unfrequented paths: for I have tried to make a collection of such facts and experiences as lie outside the usual course of our work.

The original drawings in the book were done by my wife. Dr. Hunter has been so good as to review what I have written, and to keep it free from mistakes in those parts of it that are medical rather than surgical. M. Réclus has let me add to it a translation of his address at the French Surgical Congress last year.

Prof. Polaillon's very valuable work ("Affections Chirurgicales du Tronc," Paris, 1896), contains many cases which I would have noted: but it was not published till this book had passed out of my hands.

57, Wimpole Street, W.,
June, 1896.

CONTENTS.

PART I.—INJURIES OF THE CHEST.

PART II.—DISEASES OF THE CHEST.

LIST OF PLATES.

ADDENDA ET CORRIGENDA.

1. *Fractures of First Rib and of Sternum* (Chap. III).—I have omitted a reference to Mr. Arbuthnot Lane's valuable papers in the "Transactions of the Pathological Society," 1883, 84, and 85. See also Dr. Rolleston's paper, in the "Transactions" for 1891.

2. *Wounds of the Heart* (Chap. X).—The reference to Cappelen's operation will be found at the end of the chapter on the "Surgery of the Heart."

3. *Diaphragmatic Hernia* (Chap. XI).—There is a valuable paper by Dr. Jaffe, on Congenital Diaphragmatic Hernia, with a collection of twelve cases, in all of which a sac was present, in the "Pathological Society's Transactions," for 1894.

4. *Œdema of Lung after Aspiration of Pleural Effusion* (Chap. XIV).—This subject was recently brought before the Clinical Society, by Dr. West (April 10th, 1896); Dr. Hale White also reported a case at the same meeting.

5. *Extensive Resection of Ribs for Empyema* (Chap. XVIII).—Dr. F. W. Murray has lately recorded two cases of sudden œdema of the opposite lung after this operation, one on the fourth day, the other, a fatal attack, on the tenth day ("Annals of Surgery," May, 1896).

SURGERY OF THE CHEST.

PART I.—INJURIES OF THE CHEST.

CHAPTER I.

THE LANDMARKS OF THE CHEST. CONGENITAL MALFORMATIONS.

THE 'surgical landmarks' of the chest,[1] so far as we are here concerned, are not numerous. In front, we may take a line one finger's breadth from the edge of the sternum, to mark the course of the internal mammary artery. The vein lies a little nearer the sternum than the artery. A wound half an inch from the edge of the sternum may divide the artery,[2] and its blood will pour either into the pleura, or the mediastinum, or both. Behind the manubrium sterni lie the left innominate vein,

[1] "Landmarks Medical and Surgical," Holden, second edition, 1877: Truc, "Essai sur la Chirurgie du Poumon," 1885. The course of the internal mammary artery is illustrated in Sir Astley Cooper's "Anatomy of the Breast." See also Vosz, "Die Verletzungen der Arteria Mammaria Interna," Inaug. Diss. Dorpat, 1884. He gives a number of exact measurements: practically, any deep wound about half-an-inch from the sternum may divide the artery.

[2] "Toute blessure située le long du sternum à un centimètre au moins de cet os, de la première côte à la septième, lorsqu'elle a une profondeur suffisante, peut faire soupçonner la lésion de l'artère" (*Tourdes*).

and, beneath the vein, the great branches of the aortic arch. The top of the arch, and, behind it, the bifurcation of the trachea, lie behind the junction of the manubrium with the body of the sternum.

The pleuræ slope toward each other behind the sternum, and may even be in contact about the level of the middle of the sternum; but the anterior mediastinum slants a little to the left, so that a puncture through the middle of the sternum would be more likely to wound the right pleura than the left. The exposed area of the heart (area of cardiac dulness) is about covered by a circle two inches across, having its centre midway between the nipple and the juncture between the sternum and the ensiform cartilage; and a stethoscope put over the third intercostal space, just at the edge of the sternum, may cover some part of all the valves of the heart. At the sides of the chest, the edge of the pleura follows a line, slightly curved downward, drawn from the juncture between the sternum and the ensiform cartilage, to the last rib.

The lungs rise an inch or an inch and a half above the level of the first ribs; and there is a very rare congenital malformation, first noted by Cruveilhier[1] during dissection of a fœtus where one or both apices rise high into the neck, lying alongside the cervical spine. From a surgical point of view, Truc divides the lungs into three zones: upper, middle, and lower. The lower zone occupies the space between the ribs and the diaphragm, and is moulded to the surface of the diaphragm. The

[1] For references, *see* Riedinger. Of this nature was a case shown some years ago at one of the London Medical Societies—a little girl whose lungs rose so high into the neck as to form well-marked swellings, soft, crepitant, resonant, moving with the movements of respiration.

middle zone is most easily accessible, and even that part of it which lies beneath the scapula is not out of the surgeon's reach. The upper zone presents serious difficulties, yet it may be reached either in front, between the internal mammary and the axillary vessels (the internal mammary artery is a finger's breadth from the edge of the sternum, the axillary vein is $3\frac{1}{2}$ inches from the middle line of the sternum at the level of the first space, and $4\frac{3}{4}$ inches from it at the level of the second space), or from the axilla. The chest wall is thin here, and any space from the second to the fifth may safely be punctured, if the arm be held away from the side, and if care be taken of the branches of the axillary artery (the long thoracic artery lies two fingers' breadth from the edge of the pectoralis major). Truc adds the following rules for safe exploratory puncture of the lungs: in puncturing the upper zone in front, through the first or second space, direct your needle upward, backward, and outward; in puncturing it from the axilla, go upward, backward, and inward. To reach the apex of the lung from behind, just grazing the upper border of the scapula, outside the suprascapular notch, and entering the chest through the second space, is anatomically possible, but he would rather not attempt it. Over the greater part of the lung, one may safely thrust a needle 1 inch backward, or $1\frac{1}{3}$ inch backward and outward. The neighbourhood of the root of the lung must be carefully avoided. The heart must be avoided by never puncturing within the left nipple-line, or within a breadth of three fingers on the right side of the sternum. A deep inspiration, separating the ribs, is favourable to puncture.

The surgical landmarks of the posterior mediastinum are noted in the chapter on inflammation of that region.

Congenital Malformations.

Among congenital malformations of the chest,[1] we have to note the presence of gaps or clefts in the sternum, and deficiencies in the chest wall from arrested growth of the ribs. In a case lately under the care of one of my colleagues at the Metropolitan Hospital, there was on the left side of the chest a gap of four or five inches in diameter, with entire absence of bone. These gaps, like some other congenital defects, are usually on the left side of the body. Two instances of this deformity are recorded by Dr. Abercrombie in the Transactions of the Clinical Society, 1893. It was at one time believed that there is such a congenital malformation as a heart without a pericardium, but the dissections that established this belief were really cases of densely adherent pericardium.

There is a trivial deformity of the chest, which may be worth noting here, a protrusion of the lower costal cartilages on the left side, below the level of the breast, in women. I have seen three instances of it. Two of the patients came up from the country in great alarm, and all three believed they had disease of the breast, or some internal growth pushing the ribs forward. I have never seen this prominence of the ribs on the right side, or on both sides. It seems therefore to be due not to tight lacing, but to some want of symmetry of growth.

Cervical ribs, though they can hardly be called deformities of the chest, may be mentioned here. The best

---

[1] Pierre Marie has just published a valuable Clinical Lecture "Déformations Thoraciques dans quelques Affections Médicales," which includes an account of certain general congenital malformations of the chest which may accompany arrest of development of the heart or the central nervous system, "Leçons de Clinique Médicale," Paris, 1896.

clinical account of them that I know has lately been given by Tilmann.[1] They are more often found *post mortem* than noted during life. Thus, Grüber collected notes of 45 *post mortem* examinations, but only 2 clinical observations; and Pilling (1894) recorded 92 instances, all *post mortem*. They are more often double than single, but are seldom quite symmetrical. The cervical rib may not extend beyond the transverse process of the vertebra; or it may extend beyond it, but not join the first rib, or may join the bony part of it; or it may join the cartilage of the first rib; or it may have a cartilage of its own, fused with the cartilage of the first rib. Of 26 cases during life, collected by Tillmann, 13 had their attention called to the presence of the rib during the course of a long illness: 13 suffered pain from it. Ten gained relief from treatment without operation; three underwent operation successfully. All the patients were above 20 years old: he therefore supposes that a cervical rib, though present at birth, does not cause pressure-symptoms till some wasting illness, or the advance of age, has thinned the patient. In some cases, the brachial plexus is compressed, so that the patient has pain, weakness, chilliness of the arm, prickling sensations in it, loss of the sense of touch, even wasting of the limb. In others it is the subclavian artery that bears the brunt of the pressure: the radial pulse is weak, or wholly absent, the arm becomes cold, mottled, and dusky; gangrene has occurred, and even subclavian aneurysm. It is to be noted that these troubles of circulation tend toward recovery by the establishment of a collateral blood-supply. Fischer is of opinion that even if an aneurysm occur, it tends toward

---

[1] Die Klinische Bedeutung der Halsrippen. "Deutsche Ztschr. f. Chir.," 1895, xli, parts 4 and 5.

a natural cure, by extension of coagulation, beginning in the hand, up the brachial artery until it reaches the sac of the aneurysm. He would therefore not interfere unless there be signs of pressure on the brachial plexus

Should operation be necessary, the skin incision must be very carefully placed. If any muscles are attached to the rib, they must be loosed from it by subperiosteal resection (not that there is any other reason for saving the periosteum), and the surgeon must remember how near he is to the thin, loose pleura. In one case at least the operation has been followed by pneumothorax. Tilmann's own case is worth study.

A woman, aged 44, had for seven years been conscious of pain in the left side of her neck, and had noted a hard nodule there, which seemed to be slowly growing larger, and was troublesome when she turned her head or lay down in bed. Latterly she had observed that the muscles of her thumb were wasted, and that her arm was weak and chilly, with shooting pains in it. About an inch above the middle of the clavicle was a bony growth, which felt about the size of a hazel-nut. It seemed to extend upward and backward toward the transverse process of the last cervical vertebra, and forward and downward beneath the clavicle, pushing the subclavian artery forward and upward. There were marked wasting and loss of power of the arm and hand, with some loss of faradic excitability. Pressure on the growth caused pain down the arm. The colour and warmth of the arm, and the radial pulse, were not altered. A free incision was made, exposing the growth. A few fibres of the scalenus anticus were found attached to it. The scalenus medius had its proper attachment, but was somewhat thinned out over the growth. The brachial plexus crossed over it, but was easily drawn out of the way toward the middle line. Some fibres of the scalenus medius were divided. The growth was cleared by subperiosteal resection, divided in front with a chain-saw, and removed piecemeal with the cutting-forceps. A very small opening was made into the pleura, but no harm came of it. The pains in the arm slowly disappeared after the operation; but the arm was still wasted four months after it.

Deformities of the chest following curvature of the spine do not concern us here; nor are we likely to adopt a suggestion lately made by a French surgeon, that one should correct the evil consequences of lateral curvature by resection of ribs.

CHAPTER II.

CONCUSSION AND CONTUSION OF THE CHEST.

GENERAL injuries of the chest, without fracture of the chest wall or penetrating wound of the soft parts, are seldom dangerous to life. The vital organs are not exposed, like the abdominal viscera, to mortal injury by any slight contusion; nor are they, like the brain, so delicate that even a slight concussion may be disastrous. Thus we are tempted to make light of a general injury of the chest, unaccompanied by fracture, or by a serious wound of the soft tissues. But, apart from the fact that very grave and even fatal results may follow a blow or a bruise over the chest which seemed in itself insignificant, the general injuries of the chest are sometimes attended by changes so unexpected and so obscure, that they need careful consideration. As with the abdomen, so with the chest, the pressure of a carriage-wheel, or of the buffers of a railway-truck, may, even without fracture or external wound, have strange consequences, beyond the reach of diagnosis or even of guess-work. A treatise on 'run-over' cases[1] would form a valuable addition to the literature of surgery, on the lines of Kaufmann's recent work, 'A Manual of Accidental Injuries.'

Experience of cases of simple contusion of the chest, without internal injury, teaches us, first, that children

[1] Several valuable cases are given in Mr. Pitts' "Lectures on the Surgery of the Air Passages and Thorax in Children," "Lancet," October, 1893.

sometimes escape almost unhurt from accidents which would have given small chance of escape to adults: next, that the shock of these accidents is much severer in some cases than in others. There are several reasons for the frequent escape of small children when run over. They more readily roll or are pushed from beneath the wheel; their ribs are more elastic than those of an adult; the rounded shape of their chests offers greater resistance to pressure: finally,[1] since the wheel first ascends the chest slowly and heavily, and then rolls down more rapidly and less heavily from the other side, its passage would be quicker and lighter over the small round chest of the child.

The shock from such an injury varies widely, but, as a rule, it is severe. In children, there is sometimes to be noted an extraordinary swiftness of respiration. This may fairly be considered as part of the shock; but it lasts in some cases long after the usual signs of shock have passed away. There may be no dyspnœa, no duskiness of face, nothing to suggest injury of the lung: only a rapidity of sixty or even seventy respirations a minute. I do not think this symptom is so marked in adults, and I believe it is not, by itself, any sign of serious injury.

There need be no general extensive contusion of the chest to cause severe and even fatal shock. It may follow a blow from a spent bullet or fragment of shell in a battle. It has been said[2] that such injuries 'are at least as dangerous as penetrating wounds of the chest.' Even should this statement be somewhat exaggerated, there are plenty of cases to show that a slight blow, limited to one part of the chest, may be followed

---

[1] Bühr. "Ueber den Mechanismus der Rippenbrüche." "Deutsch. Ztschr. f. Klin. Chir." 1894, 39, 251.

[2] Pirogoff. "Grundzüge d. Kriegschirurgie." 1864.

by shock out of all proportion to the injury, or even by death. There is no violent or frightful crushing of the chest to account for it. To these strange cases Riedinger[1] gives the name 'Concussion of the Chest'—*commotio thoracica*. For example, in the daily papers of Jan. 28th, of the present year, there is an account of the sudden death of a woman, aged 45, at whom a boy, aged 15, had thrown a stone. 'It struck her in the region of the heart, and she at once fell back, exclaiming, Oh my breast, Oh my breast.' She became unconscious, and died before help could be obtained.[2] Riedinger gives the following cases. (1,) A man was dragging a heavy load behind him: the rope broke, he fell forward on his chest, and died at once. *Post mortem*, there was slight contusion of the chest wall, but no injury of heart or lungs (2,) A man, convalescent after diabetes, was struck on the chest with a stone thrown at him, and fell dead. (3,) An old man was suddenly struck on the upper part of the chest: he staggered back, fell, and died at once. *Post mortem*, there was no injury of heart or lungs; old valvular lesions; cut head and slight extravasations in the pia mater. But such cases as these are evidently examples of heart-failure, from weakness or valvular disease of the heart.

Riedinger sought by experiment to ascertain the exact character of the syncope which attends concussion of

---

[1] "Verletzungen und Chirurgische Krankheiten des Thorax und seines Inhaltes." "Deutsche Chirurgie," Lieferung 42. Stuttgart 1888.

[2] Dr. Austin, of Lingfield, Surrey, has kindly sent me notes of the *post mortem* examination. The right auricle was distended with blood; the left auricle, and both ventricles, were empty. There was great hypertrophy of the ventricles, the left ventricle being fully an inch thick; the tricuspid and mitral valves were incompetent, and there were vegetations on the mitral valve.

the chest. Slight blows over the region of the heart had no marked effect on the blood-pressure; it sank a little after each of them, but soon rose again to normal. A single heavy blow made it descend low at once, then it rose quickly; a second made it sink even lower than the first, but it rose again; after a third, it went lower than ever, and remained low for some time. Repeated heavy blows could not bring it below a certain level, and only caused irregular fluctuations. These fallings of the blood-pressure were not due to any direct compression of the heart itself; care was taken to avoid this. They were less marked, if the depressor nerves, and the vagi, or the cervical sympathetic, were previously divided. Concussion of the chest is a complex process. The fall of the blood-pressure after a blow is probably due to direct stimulation of the vagi: that it still occurs, though the vagi have been divided, must be due to direct compression of the heart: that it lasts for some time even after the blows have ceased, is probably due to the action of the depressor nerves and of the sympathetic, whereby more blood flows into the splanchnic vessels.

If we are called to deal with a case of contusion of the chest with severe shock, but without evident fracture, wound, or internal injury, we must not wait to make a prolonged examination, but must proceed at once to treat the shock, much as we treat a case of syncope from chloroform, laying the patient flat with his head lower than his body, using warmth, stimulants, hypodermics of ether or strychnine, or both, and very hot cloths, or the faradic current, over the heart. It may even be necessary to do artificial respiration.

The external injuries in simple contusion of the chest, and simple superficial wounds of the soft parts, as a rule

heal rapidly; the intercostal and internal mammary vessels, being uninjured, are left free to carry on the work of repair. The superficial veins are hardly large enough to cause any large subcutaneous hæmorrhage. Riedinger, however, notes a case of very extensive extravasation under the skin of the back after contusion of this region; and blows over the breast may have a like result. The worst case of this kind I have ever seen was that of a young soldier whose horse in a fit of rage had seized him over the left breast. The whole breast, and the tissues round it, were distended and uplifted off the pectoral muscle by a profuse extravasation, and were for many days so tense that the skin seemed on the very point of breaking down; but slowly the whole of the huge clot was absorbed, without suppuration. It is of the utmost importance that one should thoroughly cleanse and disinfect any lacerated wound of the soft parts. For if suppuration take place among or between the intercostal muscles, it may burrow quietly far and wide, prevented by the deep fascia and the pleura from making its way into the pleural cavity, and by the ribs and muscles from making its way outward under the skin.

The internal injuries that may be caused by simple general contusion of the chest, even without fracture, range from the slightest rift in the pleura to the most extensive laceration of the lung. These injuries are more likely to happen if the accident comes very swiftly and unexpectedly, at a moment when the lungs are fully expanded, and the glottis closed.[1] Emphysema, pneumothorax, pleurisy with effusion, hernia of the lung, hæmothorax, laceration of the heart or lung, rupture of the diaphragm—all these have been noted after simple con-

[1] Gosselin: Déchirures du Poumon. "Mem. Soc. Chir." i. 201.

tusion without fracture; nor, if one or other of them occur in a case where the ribs or the sternum are fractured, does it follow that the fracture had anything to do with it.

We are bound therefore not to think lightly of contusion of the chest merely because there is no fracture or external wound. I can find no evidence that contusion alone can bring about rupture of an intercostal or internal mammary artery; but, however this may be, the list of possible lesions is long enough to warn us to be watchful. Absolute rest in bed, immediate treatment of the shock, careful observation of the patient till one is sure that no internal harm has been done—all these precautions are necessary in every case of severe contusion.

CHAPTER III.

FRACTURES AND DISLOCATIONS OF THE RIBS, COSTAL CARTILAGES, AND STERNUM.

It is impossible to make a satisfactory division of the various injuries of the chest, or, having made it, to keep to it. Perhaps the best that can be done will be to devote this chapter to the simple fractures and dislocations of the ribs, costal cartilages, and sternum, as they are in themselves, giving separate chapters to some of the grave dangers and troubles that may be caused by them, or may accompany or follow them. A case of simple fracture of the ribs, with extensive emphysema or profuse hæmoptysis, presents itself to us, not as a case of fractured ribs, but rather as emphysema or as wound of the lung. It is absurd to consider the emphysema or hæmoptysis as less important than the fracture; it is just the wound of the pleura, or lung, that we have most to consider.

Simple Fractures of the Ribs.

There is so much valuable work on this subject in the writings of Malgaigne, Gurlt, Riedinger, Hamilton, Poland, and many others, that the experience of one surgeon is of little value. And the subject itself is so wide, that I do not attempt, even from the work of others, to treat it at length.

The most frequent seat of fracture is somewhat toward one or other end of the rib; and the rib most often broken is the fifth or sixth. Cases are recorded of

fracture of the eleventh or twelfth rib, by direct violence As regards unusual forms of fracture, it is certain that there is such a thing as true sub-periosteal fracture; or the external or internal surface alone, or the upper or lower border alone, may be fractured; and in one case of this kind, the intercostal artery was lacerated. One or more ribs may be fractured, probably by muscular effort, remote from those broken by direct violence. A rib may be fractured in two places, and the fragment displaced inward. The usual division of fractures of the ribs into fracture by direct violence with internal displacement, and fracture by indirect violence with external displacement, is too strict to suit the complex character of these injuries. As Poland has pointed out, the same violence may act both directly and indirectly; and in seventy specimens of fractured ribs, many of them plainly due to indirect violence, Bennet did not find one that showed outward displacement.

Fracture of the first rib is very rare; but I have had one case where both first ribs were fractured, toward their middle, by a fall. Of 61 cases (Poland), 44 were between the fourth and the eighth ribs, 13 among the last four, and 4 among the first three; in only 9 was the fracture limited to a single rib.

As to complications, Poland found that of 136 cases, 108 were free from complications, 16 had emphysema (4 of these also developed pneumonia, but recovered), 3 had hæmoptysis with emphysema, 3 severe secondary inflammation, 6 died at once from shock. These figures are more encouraging than those of Settegast,[1] who gives 20 cases of fracture of one to four ribs: 1 died of delirium tremens, 3 suffered extensive emphysema,

[1] "Langenbeck's Archiv.," 1879, xxiii., 274.

3 traumatic pleurisy, 4 pneumothorax and hæmothorax, and 7 had injury of the lung. I do not remember to have had a death from simple uncomplicated fracture of ribs.

The relation of old age, and of such wasting diseases as phthisis, scurvy or mollities ossium, to fracture of the ribs, and the strange brittleness of the bones in some individuals or some families, need be mentioned only. Two subjects may be considered at some length: these are, fracture of the ribs by muscular effort, and fracture in the insane.

Malgaigne, in 1841, noted that 'spontaneous' fractures of the ribs usually occur on the left side, and toward the anterior end of the rib. Doubtless, in some of these cases, the rib is predisposed to fracture by old age or disease; but the same thing may occur in young and healthy people. It has arisen from a severe fit of coughing; after sneezing; in the pains of labour; on lifting a heavy load; or swinging a scythe; and during the performance of acrobatic feats. Gurlt[1] says of it, 'When we consider how great violence the ribs can withstand, it is hard to understand the isolated fracture of one or two of them by mere muscular action. Yet I know of fourteen cases. Of these, ten were due to a violent cough; one came from a resolute effort to keep back a sneeze, one from turning in bed, one from riding a restless horse, one from the patient's attempt to save himself from slipping. Age and general health have nothing to do with it. In three of the cases, two ribs, next each other, were broken; in another case, the patient on three successive occasions broke one each time, each rib next the other. Usually the lower ribs

[1] "Ueber Knochenbrüchen," i., 216.

are thus broken, the seventh to the eleventh; and in almost all the cases they were broken far forward.' Two of Gurlt's cases will serve as examples of this curious accident. A strong, hearty man, aged 40, standing during a violent cough, was suddenly seized with a pain in his side so severe that he nearly fainted, and remained for some time unable to cough or move; he had fractured the eleventh right rib, about the middle. A man, aged 39, in vigorous health, to stop a fit of sneezing, drew a deep breath and held it. At the moment of sudden expiration, he heard a rib give way, and was seized with severe pain in the left hypochondrium, difficulty in breathing, and agonizing cough; there was an oblique fracture of the ninth left rib, about the middle.

For fracture of ribs in the insane, we may take the figures given by Gudden,[1] Hearder,[2] and Wiglesworth. Gudden, in 100 general *post-mortem* examinations of the bodies of the insane, found 16 cases of fractured ribs. The majority of the patients had died of general paralysis. In one instance there were 14 fractures, in another 23, in another 30. Hearder, in 20 similar examinations, found well-marked changes in the ribs in 9 cases; they were thin, brittle, and poor in calcium salts. Wiglesworth, in 30 examinations, found only 8 cases where the ribs appeared perfectly healthy. In 17, there were slight changes, chiefly vacuolation of the bone, 'the general failure of nutrition, so common in insanity, or with phthisis or senile decay'; in 3 only, were found 'clear and precise lesions, produced by considerable internal absorption, which renders the bone

[1] "Archiv. f. Psychiatrie," 1870.
[2] "Journal of Mental Sciences," 1871.

very porous and brittle, and sets up the condition known as osteoporosis, probably having a causal connection with insanity.'

In 1870, Edward Ormerod wrote an admirable account of fractured ribs in two cases: one a woman, aged 58, acute mania; the other a man, aged 46, general paralysis with melancholia. 'The bones were brittle and soft, allowing a scalpel to be passed through them. When bent, they snapped suddenly with a clean fracture without splintering. All the strength of the bone lay in its outer shell of compact tissue, which yet was no thicker than cardboard.' The microscope showed fatty and granular degeneration of the whole bone, with dilatation of the Haversian canals.

In 1890,[1] Dr. Claye Shaw wrote a most valuable essay on the whole subject. He tested the breaking-weight of healthy ribs, fixing their heads in a vice, and hanging weights from their free ends. The average breaking weight of the eighth rib was about 15 lbs. for a man, 10 for a woman. 'It thus appears that ribs, taken fresh from a body, and supported only at one end, break under a comparatively small weight. Weight-striking machines are graduated up to 500 lbs., and we may reckon 300 lbs. as representing the force of a severe blow. Yet even a heavy, powerful man is unable, by the strongest blow he can give, to break an opponent's rib by a direct blow, unless it is delivered when the opponent is placed at a disadvantage, *e.g.*, is turning sharply round.' The contrast between the light breaking-weight of a rib removed from the body, and the heavy direct blows in boxing, which yet do not break a rib, shows that

[1] "St. Bartholomew's Hosp. Reports," xxvi., p. 15. See also Dr. Campbell's paper on this subject, "Brit. Med. Journ." September 28, 1895.

fracture of ribs in the insane is due not to the violence of their attendants, nor to any special structural changes in the bones, but to the way in which a restless or struggling patient throws himself into such a posture that a very slight pressure is enough. 'The dictum, that the ribs of the insane are more brittle than those of the sane, is true to a very limited extent only, and is almost confined to those affected with degeneration of the circulatory system.'

Mr. Macnamara[1] agrees that there is no special disease of the ribs of the insane. 'I commenced my researches,' he says, 'fully expecting to meet with some interesting pathological changes in the bones, but I have been disappointed. For, as I worked on at specimens of this kind, I gradually arrived at the conclusion which I now hold, that neither the ribs nor other bones of insane patients are liable to any peculiar abnormal changes. It seems to me more probable that the injury has been caused by the attendants kneeling on the patients' chests to keep them from moving.'

The weight of evidence seems to be against the occurrence of any definite changes in the ribs of the insane directly due to insanity. Also, it seems certain that an insane patient, already weak and wasted, may expose himself to fracture of a rib by a very slight pressure; just as one has heard of fracture of a rib in an anæsthetized patient, during the performance of artificial respiration. It is to be noted that Gudden and Hearder wrote a quarter of a century ago, when the treatment of the insane was very different from what it is now.

The grave dangers and difficulties due to or accom-

---

[1] "Diseases of Bones and Joints," 3rd ed., p. 251.

panying severe fractures of the ribs and injury of the whole chest—pneumonia, emphysema, pneumothorax, laceration of lung or heart, and other internal injuries—will be considered in chapters by themselves. A case of simple fracture, apart from all these troubles, runs a smooth course, and non-union is a thing almost impossible; even Gurlt, in his great work on fractures, could find only three instances of it.

It is in some cases almost impossible to determine whether a rib has or has not been fractured; as when the patient is very fat, intolerant of the least pain of examination, or half drunk. A blow with the fist is more likely to cause contusion than fracture; a crush or run-over accident, if pain be felt about the middle of the rib, is more likely to be fracture than contusion. There is often no crepitus; as when the rib is simply cracked across, or the broken ends have slipped one over the other, or the soft tissues have got between them. The right method of examination is to feel carefully, inch by inch, the whole accessible length of each rib; and to lay one's whole hand, for some minutes, over the seat of pain, in the hope of catching a chance movement of the broken ends. One is not likely to learn anything from pressure on the two extremities of the rib. If, after the first suffering of the injury has passed off, the patient still complains of a sharp pain, always in the same place, worse on coughing or drawing a deep breath, and seizing him suddenly just at the end of the inspiration; if his respiration is still quick and shallow, and he finds ease in one posture, and not in another, there is good reason for believing that one or more ribs are broken.

The treatment of simple fracture of ribs, without other injuries, requires all common-sense methods that may best ensure rest in bed, easy breathing, light diet,

and freedom from cough and pain ; and it is of great importance that aged patients should not be kept long on their backs. The necessary restriction of the movements of the chest and of the broken ribs may be secured as well by a well-adjusted bandage as by strapping, if not better ; and this saves the patient from all irritation of the skin, and from the uncomfortable process of having the strapping finally removed. The bandage may be applied from the lower ribs upward, at a moment when the patient has just emptied his lungs of air ; but this rule is not of great importance. To prevent the bandage from slipping down, the surgeon should first place a long strip of broad bandage, with a slit in the middle, over the patient's head, so that it lies round his neck, with the ends hanging down in front and behind ; then, having applied his bandage round the chest, over the strip, he turns up the ends of the latter over the bandage, pinning them so that they hold it in its place.

We should remember that a bandage may cause pain instead of alleviating it. A man[1] broke his tenth left rib by falling against a table : when lying on his back, he was free from pain ; but when a circular bandage was applied, he suffered so much pain that it had to be removed. In this case, there was marked displacement, which disappeared, with a crepitus, when he coughed. In such cases, a bandage must not be used ; and the patient will be healed just as well without it.

Fractures of the Costal Cartilages.

It is seldom that the costal cartilages are fractured, and when this occurs there are usually other injuries of the parts beneath. They are, as a rule, fractured

[1] See Nélaton's "Lectures on Surgery," Atlee, 1855, p. 156.

by direct violence, though a few cases have also been noted of fracture by muscular effort. The fibrous and calcareous degenerations of old age may be predisposing causes. The usual site of fracture is about the juncture between rib and cartilage; but this is not a true joint, and we must therefore reckon the lesion as a fracture, not a dislocation. The most common cause is a fall against some such obstacle as the edge of a table; and the cartilage most likely to be fractured is the eighth; those next above it are more often broken than those below it. Usually, the sternal fragment is displaced inward, and the costal fragment outward. Non-union is very rare, but some few cases have been recorded. In one, suppuration occurred round the broken ends, which became the seat of necrosis; they were resected, but the wound did not heal, and the patient died a few months later of tuberculosis.

The following cases from Gurlt illustrate the usual course of fracture of the costal cartilages:—

1. A man, after general contusion of the chest, suffered pain and slight dyspnœa, and the 4th right costal cartilage was found driven backward and downward; deep inspiration reduced it, but expiration again displaced it. There was no external bruise. It was reduced, kept in place with a bandage, and healed without any trace of displacement.

2. A young man struck the right side of his chest against a balustrade; ten days later, his surgeon found a fracture of the 5th right costal cartilage, about an inch from the sternum. When the patient stood up, the inner fragment was thrown forward, but went back on gentle pressure or on deep inspiration; it was most prominent when he lay on his left side, less when he lay on his back, least when he lay on his right side. Two different bandages were tried, but failed. Finally, a soft compress and an elastic bandage were applied, with an elastic air-pad; with these, the fracture healed in twenty days without the least deformity.

3. A man, aged 33, was knocked down with a blow on the chest, and next day was feverish, with pain, made worse by

every movement of respiration. There was a hard bruise, with a very painful central spot; the 4th costal cartilage was fractured about half an inch from the sternum; the inner fragment was depressed, and freely movable. By means of a compress, bandage, and tight flannel vest, the pain was relieved and the displacement lessened. The fracture healed in a month, with a slight smooth oval thickening of the injured cartilage.

A very severe crush of the chest may cause extensive fracture of the costal cartilages, and yet the patient may recover. The case has been recorded of a child, 7 or 8 years old, crushed between a cart and a wall, in whom every cartilage down one side was fractured. The sternal fragments were displaced forward; they went back on gentle pressure, but it was hard to keep them in position. A man,[1] after a like accident, had fracture of all the cartilages of both sides, 'so that his chest felt like that of a body on the *post-mortem* table, when the costal cartilages have been divided to remove the sternum.' The left clavicle was also dislocated at its acromial end. His state on admission seemed hopeless. He was bled and bandaged, and in twenty-five days made a good recovery, with only slight deformity.

Non-union of fractured costal cartilage has been noted, but is very rare. The exact process of union has been explained in more ways than one. Riedinger is of opinion that the cartilage itself takes no part in it; the fragments lie inert, rounded off, one over the other, separated by fibrous tissue; a callus of spongy bone, with large lacunæ, is formed round them, and in the angle between them.

The treatment of a fractured costal cartilage is a matter of careful reduction and fixation, with restriction of the chest with a well-adjusted bandage. 'If we cannot reduce

[1] Sir Chas. Bell, "Middlesex Hosp. Reports," 1816, viii., p. 171.

the displacement, if permanent pressure fails, if a deep inspiration does not reduce it, if we gain nothing by turning the patient on to the sound side, or by putting pillows under his back, we have come to the end of our resources, and must let the fracture heal with deformity.'

Dislocations of the Ribs.

It is plain from the shape, texture, and attachments of the ribs that they are easily fractured but not easily dislocated. As to separation of the head of a rib from its articulations with the spinal column, this is a wonder of the *post mortem* room, and it has not been found possible to produce it on the dead body. Nine or ten instances have been collected by Riedinger from various sources. In one only, was it unaccompanied by other severe injuries. The subjects of it were young, the oldest being 44. From the fact that in five of them the eleventh rib was displaced, and in three of them the twelfth rib, it is plain that the displacement is due to great external violence. I need not say that it is more likely to be found after death than made out during life.

Dislocation of a costal cartilage from the sternum is also very rare. I lately saw a case, where the fourth left cartilage was slightly displaced forward, and movable: it was easily replaced, but would not stay in position. Out of 19 cases collected by Riedinger, the fourth cartilage was dislocated in 6: the fifth in 4: the sixth in 4: the fourth, fifth and sixth all together in 3: and the second in 2 (one of these was double). As a rule, the cartilage is displaced forward, a displacement which cannot be produced on the dead body, and I do not know of any *post mortem* example of it. 'Sir Charles Bell has seen it produced by violent extension of the arms during exercise with dumb-bells: Bransby Cooper saw a luxation of the fifth

and sixth cartilages in a boy, produced by the constant action of the pectorals in kneading bread.'[1] In some cases, it is hard to decide whether the cartilage was dislocated or fractured. The forward displacement is easily reduced. In one case, where three cartilages were thus displaced, reduction was effected by arching the back over pillows placed under it. The backward displacement is more rare, more serious, and more difficult to reduce. The usual method of pressure on the sternum, while the patient takes a deep breath, may fail. Nor can much be expected from the ingenious method of Negretti, who, when everything failed, dashed cold water over the patient's face, and effected reduction during the gasp for breath that followed.

The lower cartilages, the sixth to the ninth, may, it is said, be displaced: but probably these are cases of fracture, not of dislocation. From the cases quoted by Poland, it appears that the displacement is due to sudden violent effort (lifting a heavy weight, struggling to avoid falling) and is not easily reduced. Forward and backward displacements have both been recorded.

Fracture and Dislocation of the Sternum.

These injuries are so dangerous, and of such great interest, that they have at all times had a special attraction for surgeons, and there has gathered round them a great wealth of literature. They are seldom seen alone: Gurlt, in a collection of more than fifty thousand fractures of all kinds, found only fifty-two fractures of the sternum; Lonsdale,[2] in a similar collection of nearly two thousand, found only two. Even in combination with other injuries

[1] Poland, "Holmes' and Hulke's System of Surgery." i. 817.
[2] "Amer. Journ. Med. Sciences," 1862, p. 411.

(fractured spine or ribs) they are still very rare. One might suppose that a bone so exposed and presented to all sorts of violence would often be broken, but the exquisite curves and elasticity of the ribs and their cartilages allow pressure on the sternum to be at once distributed far and wide away from it. Messner[1] has found that in the dead body of a child you can make the sternum touch the spine without breaking any bone, and in the bodies of older people can bring them within an inch or two of each other. Again, the sternum moves not only with the costal cartilages, but also to some slight extent upon them, and may thus yield a little to any crushing weight; and through early life the sternum itself is elastic, and not yet welded together. Hence, out of all the recorded cases of fracture, only three occurred in patients less than twenty years old.

The unusual forms of simple fracture (longitudinal, oblique, partial, comminuted, and so forth) are so rare, that the only form to be noted here is that which occurs between the manubrium and the rest of the bone. Fracture or displacement of the ensiform cartilage must also be considered. Compound fractures of the sternum do not come from protrusion of the broken bone through the skin,[2] but only from wounds of the chest wall.

In the usual form of displacement of the sternum, the bone gives way at, or just about, the line between the manubrium and the rest of the bone. The upper fragment is depressed, the lower fragment rides over it; the second ribs usually go with the manubrium.

Is this a fracture, or a dislocation? Poland speaks of it as the latter. 'The symptoms are liable to be

[1] "Elasticität der Knochen," 1880.

[2] Gurlt found only one recorded case where this happened.

PLATE I.

The usual form of Displacement of the Sternum. From Gurlt, Ueber Knochenbrüchen, vol. i. (The small piece of bone behind the body of the sternum is a fragment that has become re-united to it.)

mistaken for fracture at or about the same level. But in dislocation there is a marked projection of the lower fragment, and this can be recognized as the articulating surface by its three smooth articulating facets, one central for the manubrium, and two lateral for the costal cartilages.'

Riedinger and Gurlt make no mention of the possibility of feeling these facets, and treat the question as of no importance. The signs in either case are the same, and specimens have been described by one man as fracture, and by another as dislocation. So far as experiment goes, we find that even where there is a distinct sort of joint between the two fragments, we still fail to produce a true dislocation; the cartilage may be left on the upper fragment, or on the lower, or some of it on each. If there is no joint at all, it is a fracture; if there is a joint, it is a dislocation. We do not know before the accident, and cannot tell after recovery, whether there was a joint of any kind, or not.

Brinton[1] examined 30 specimens of the sternum, and found in 3, bony ankylosis; in 7, union by fibro-cartilage; in 20, a true joint with a synovial sac (18 of the 20 had a single sac, 2 had a double sac, and 1 had a sac communicating with the articulations of the second costal cartilages).

Rivington[2] examined 100 specimens, of all ages. He found bony ankylosis in 6; fibro-cartilage in 51; true joint, but not fully developed, in 11; true well developed joint in 32.

Maisonneuve found, in the majority of the specimens which he examined, even in the bones of the aged, a true joint, without a trace of ossification.

---

[1] "Amer. Journ. Med. Sciences," July, 1867.
[2] "Med. Chir. Soc. Trans.," 1874, lvii., 101.

Each segment of the sternum is clothed with a distinct layer of cartilage. That of the upper segment is adherent to the second costal cartilages; that of the lower is continuous with the facet on the side of the sternum for the second costal cartilage. Therefore, in the displacement of the sternum, the second ribs go with the manubrium.

These facts show plainly that we ought to keep the name of fracture for such injuries of the sternum as occur away from this joint, and for such cases as that recorded by Rivington, where an acrobat falling on the back of his head broke his cervical spine and drove his chin down on to his sternum. An *oblique* fracture was found, from a point between the first and second costal cartilages on the right side to the third costal cartilage on the left side, traversing the articulation of the sternal segments, but not following it. The usual displacement is, from the anatomical point of view, a dislocation rather than a fracture.

There are many different explanations of the manner in which this displacement is produced. Direct violence is of course easy to understand in some cases of true fracture of the sternum; but when direct violence is followed by the displacement of the manubrium behind the gladiolus in the usual way, has the manubrium been driven in behind the gladiolus, or has the gladiolus, by the elasticity of the ribs, or by some forward tilting of itself, been thrust forward in front of the manubrium? Again, in such displacement after falls on the back, is there any meaning in saying that the displacement was the result of *contrecoup*, or any reason for attributing it, as Riedinger does, to sudden strong contraction of the muscles attached to the sternum? Or is it not rather due to forcible flexion or extension of the spine thrusting the

ribs forward? Or is the shock transmitted along the clavicles rather than the ribs?

Such problems are easily set. The weight of evidence, carefully considered by Rivington, may be formulated in some such way as the following:—

1. It is sometimes impossible to say what is direct violence, and what is indirect. Probably, in most cases of direct violence, as where a man is run over, the gladiolus is carried forward, over the manubrium, by the rebound of the bent ribs. One can hardly see how direct violence could drive the manubrium backward, behind the gladiolus. The manubrium is only a square inch or so in size, and direct violence could hardly drive back this small and firmly fixed piece of bone without breaking the clavicles and tearing the neck.

2. Driving forward of the chin on to the sternum may produce fracture, but such cases must be rare indeed. It could hardly, of itself, produce the usual form of displacement.

3. Muscular effort may cause, or help to cause, fracture or displacement of the sternum—as in several cases during the pains of labour, and in the case of an acrobat, who bent himself far back to pick up a weight with his teeth. But it is not probable that muscular effort has much to do with fracture or displacement of the sternum from fracture of the spine.

4. Sudden extreme flexion of the spine, as by the falling of a heavy weight upon it, may cause displacement of the sternum.[1] In such cases, the upper dorsal spine is usually fractured. The force is probably transmitted through the clavicles as well as the ribs.

---

[1] In one case, the sternum was thus dislocated by a bone-setter forcibly flexing the patient's spine to relieve rheumatic pains in his back.

5. Sudden extreme extension of the spine, as by falling on the back, may cause displacement of the sternum. In such cases, the manubrium being restrained by the first and second ribs, the gladiolus is carried over it by the longer, more movable, lower ribs.

6. In the usual forms of fracture and displacement, the anterior ligaments are torn, the posterior ligaments are loosed from the gladiolus, and uplifted from it by the manubrium. The periosteum goes with the ligaments. It is rarely stripped further than the third ribs. But, in fracture from direct violence, one may find the posterior ligaments torn, not the anterior.

The signs of fracture or displacement, though in this or that case they may be absent, are as a rule only too evident: marked deformity, pain, swelling, troubled breathing, inability to move, great distress and oppression, rigid flexion of the cervical and upper dorsal spine—to all these may be added emphysema, hæmoptysis, signs of laceration of the internal mammary vessels, or of the heart. I quote from Gurlt a few cases which are of interest, as illustrating the causes, results, and treatment of such injuries. It is worthy of note that in two of them the lower fragment was displaced not forward but backward.

1. A man, aged 37, run over, had slight hæmoptysis, and that night was ill and feverish. On admission to Hospital, four days after the accident, he was suffering from fever, dyspnœa, and an almost incessant cough, with blood-stained sputa. The soft parts over the sternum were much bruised, and the whole front of the chest was emphysematous, so that it was impossible to make an accurate examination. He died on the ninth day. *Post mortem*, the sternum was fractured through its middle third, and there was a quantity of coagulated blood in the anterior mediastinum.

2. A man, aged 23, was struck a heavy blow on the chest, and the upper part of the body of the sternum was fractured. The lower fragment was displaced *inward*, and lay behind

the upper fragment: he suffered from dyspnœa, with intense pain on deep inspiration. Many attempts at reduction were made in vain. After several days, during a severe fit of coughing, the lower fragment suddenly returned into place.

3. A man, aged 43, was crushed between a cart and a wall. The sternum was fractured across the middle; the lower fragment was displaced *inward*, and locked beneath the upper fragment. He was collapsed, with shallow, rapid breathing, and pain. The next night, while turning in bed, he felt something snap, and his dyspnœa was relieved. The displacement had disappeared.

4. A man, aged 50, fell from a height, and on recovering his senses, some hours later, had intense sternal pain, worse on movement and on deep breathing: his head was bent far forward, and he could not put it straight. For several days he suffered from faintness, tinnitus aurium, hæmoptysis, dyspnœa, and retention of urine. There was no paralysis of the limbs. On admission to Hospital, twelve days after the accident, his head was bowed so far forward that his chin touched his sternum, and his chest hardly moved in respiration. There was an oblique fracture of the sternum; the upper fragment, which was slightly movable, was displaced inward, carrying the third costal cartilages with it. The displacement was partly reduced by keeping him on his back without a pillow. He recovered, but with some deformity.

5. A man, aged 60, leaping from some height, came down heavily in a sitting posture, and fractured his sternum. The manubrium was displaced inward, carrying with it the sternal end of the second left costal cartilage, which was fractured. He suffered severe sternal pain, worse on pressure and on deep breathing. He was kept at rest for a fortnight, with pillows under his back, and firm, steady pressure was made over the lower fragment. In a month he was fit for work again, and the deformity was less marked than at the time of the injury.

6. A man, falling on the gunwale of a boat, fractured his sternum between the manubrium and the rest of the bone. The manubrium was displaced inward; the second left costal cartilage went with it; the second right costal cartilage was left behind, projecting under the skin. He suffered severe pain for many days; and three weeks after the injury his breathing was still laboured, and he could hardly raise himself in bed. Repeated attempts at reduction were made in vain, with pillows under the lumbar spine, and extension and

counter-extension of the trunk. An operation was proposed, but refused.

7. A woman, falling from a ladder, suffered fracture of the sternum. The manubrium was displaced behind the gladiolus; she had severe dyspnœa. Many attempts at reduction were made in vain, including the old method of laying the patient backward over a tub. Finally, she was set on the edge of her bed, an assistant put his knee between her scapulæ and drew her shoulders upward, the surgeon pressed the ribs downward, the patient took a deep breath, and the fragments returned into place.

These cases are all worthy of observation; for they put in a clear light the usual signs and course of fracture or dislocation of the sternum. As regards treatment, I fear the surgeon must not presume on the possibility that the displacement will correct itself; though he would be justified in leaving it to itself if it gave no trouble, and if the patient were old or feeble, or unfit for active treatment. The cases quoted indicate the sort of postures and manipulations by which the surgeon may hope to effect reduction; the careful use of an anæsthetic may also help him. Nor do I see why we should scoff at the idea of putting a patient backward over a tub any more than we do at the Trendelenburg position for abdominal operations.

Again, all methods of dragging at the fragments with sharp hooks, or levering them into place, are now condemned past appeal. But they were used long before Lister had made a new thing of surgery. What, in the present day, should prevent a surgeon from cutting down on the fragments, reducing the displacement, if necessary, by removal of bone with the cutting-forceps or the trephine, and wiring the fragments? There is the fear of opening the pleural cavity, or of letting air into it, if it be already lacerated. A lacerated pleura, however, is healed in two or three days. Only in rare cases could an operation be proposed; but, at least, it is possible that an

operation, wrong in the days of Malgaigne and Cooper, would be right now, for the relief of a case of urgent dyspnœa, intense pain, and inability to move about; and such an operation might avert the danger of mediastinal abscess—a calamity which not unfrequently follows fracture of the sternum.

On the other hand, it must be recognized that a patient may recover with serious permanent deformity, or with non-union, and yet enjoy fair health. A man kicked by a horse, suffered comminuted fracture of the sternum, with so great depression of the fragments, that one could lay the head of a six-year-old child in the hollow. Two years later, save for occasional spitting of blood, he was quite well, and respiration and circulation were both normal. A man, who had suffered fracture of the sternum by muscular effort, and had for several months been strapped up in plaster by an amateur surgeon, two years later had non-union of the fragments. The lower fragment, lying over the upper, was slightly movable from side to side, but he had no trouble from it.

Fracture or Displacement of the Ensiform Process.

Special attention was given by the older surgeons to this injury, because of certain cases where inward displacement of the cartilage had been followed by signs of pressure on the stomach, pain in that organ, and persistent vomiting. It is probable that they exaggerated the importance of this curious association of vomiting with displacement of the cartilage. For two of the cases reported by them occurred in pregnant women, and the vomiting may have had no close relation to the displacement. The following cases, however, appear to place the fact itself beyond dispute.

1. A man, aged 28, fell forward on a candlestick, and drove in his ensiform cartilage at right angles to the spine. For the next two years he suffered frequent attacks of vomiting, occurring every fifth or sixth day. Operation was proposed, but refused. Twelve years later, the process was still at a right angle with the sternum, pointing straight toward the spine; but he had no trouble from it, save pain on coughing.

2. A boy, aged 18, had his ensiform cartilage driven in by a blow. He suffered frequent vomiting, which continued until the cartilage was reduced by manipulation.

3. A boy, aged 19, after falling forward on the edge of a boat, was seized with shortness of breath, pains in the stomach, and intractable vomiting. For three weeks, in spite of treatment, he vomited everything, till at last he was in danger of death. Careful examination now showed for the first time slight depression of the ensiform cartilage. Nine days later, when he was now almost exhausted, an incision was made alongside of the process into the peritoneal cavity, and with a blunt hook the displacement was reduced. He immediately called out that he felt such relief as he had never had since the injury. The vomiting never occurred again, and he made a complete recovery.

Cases of lateral or forward displacement of the cartilage have been recorded, but without vomiting. It is to be noted that the backward displacement may in some cases be reduced by manipulation. If this fails, and if the deformity causes pains in the stomach or vomiting, it should be reduced by operation. A case of non-union, in a man aged 60, has been recorded by Clarus. The cartilage was displaced upward and toward the left side. Nine months after the injury, it was still movable, with crepitation, but gave him no pain.

CHAPTER IV.

CASES OF SIMPLE FRACTURE WITH INTERNAL INJURIES.

THE internal injuries and inflammations that may attend or follow simple fractures of the ribs or sternum are so many and so grave, that it would be wearisome to consider them all in one chapter. Most of them, therefore, though often mentioned here, are more fully discussed later. At present, we are concerned only with the general course and treatment of those most anxious cases where the fear or certainty of internal injury is of more importance than the fracture. It may be convenient to take these injuries in order, according as the pleura, the vessels of the chest-wall, the lungs, or the heart, may be affected; only noting that practically it is the conjunction of two or more such injuries that makes these cases so serious and difficult.

INJURIES OF THE PLEURA.

Fracture, or even contusion without fracture, may be followed by acute or subacute diffuse inflammation, tending to suppuration in the loose connective tissue between the pleura and the intercostal muscles (peri-pleuritis, retro-costal abscess, phlegmon endothoracica). This was first described by Boyer, in 1824, under the title of "Abscess of the cellular tissue of the pleura"; but without clearly distinguishing it from tubercular abscess. 'In acute cases, the patient suffers sharp, deep-seated localized pain, fever, troubled breathing, and a dry cough. These symptoms continue unabated for several days; then they become

less marked, and the patient has shivering fits now and again. Soon a doughy swelling appears at the seat of pain, and goes on rapidly to fluctuation.' Such is Boyer's account; an acute or subacute phlegmonous inflammation, marked by rigors, feverishness, œdema, and tending to the formation of thick pus; it may also be accompanied by albuminuria. It very seldom penetrates the pleura, but points outward, and may easily be mistaken for empyema. It does not, however, gravitate downward; does not alter its level with any change of posture; does not become more tense during violent expiration; there is no separation of the ribs, no displacement of the heart, and no great collection of pus. Of 8 such cases collected by Bartels, 4 died: but his paper was published twenty-two years ago. It must be treated early by free incision.

A more common affection of the pleura after fracture of the ribs is a slight, limited irritation or inflammation; there may be a friction-sound, and slight adhesions may be set up; but I have never known any further trouble ensue. Billroth has noted it in 10 cases out of 58. Israel has recorded a case of pleural effusion after fracture of ribs, remaining still unabsorbed four months after the injury; it was then punctured, became purulent, and the patient died. The following cases quoted by Gurlt serve to show that a very copious pleural effusion, serous or purulent, may follow simple fracture of ribs.

1. A boy, aged 12, fell and broke the fifth, sixth and seventh ribs on the right side. Six days later, there were signs of pleural effusion; and on the tenth day the sixth space was punctured, and 6 ounces of serous fluid evacuated. On the fourteenth day and following days, pus was let out. On the seventeenth day he died; 16 ounces of pus were found in the pleural cavity, and the lung was compressed to one-third of its proper volume.

2. A man, aged 42, fell and broke the seventh, eighth and ninth ribs on the left side. This was followed by a pleural

effusion ; on the thirteenth day, the fifth space was punctured, and 6 ounces of pus were let out ; two days later, 10 ounces more. He died the next day, and 80 ounces of sero-purulent fluid were found in the pleural cavity. The lung was so compressed as to be wholly useless.

3. A man, kicked by a horse, suffered fracture of the fourth and fifth left ribs ; no hæmoptysis ; slight emphysema. On the fourth day, he had acute pleurisy ; and on the ninth day, there were plain signs of a large pleural effusion. Nothing was done till the twenty-fourth day, when there was bulging of the fourth space, with fluctuation ; 18 ounces of pus were evacuated by puncture. He made a good recovery.

These cases happened long ago, and I quote them, not for the sake of the treatment, but to show that one must bear in mind the possibility of pleural effusion in any bad case of fractured ribs. Probably slight laceration of the pleura frequently occurs without any bad results. Not long ago, in the body of a man who died of other injuries, I found three very small lacerations beneath three fractured ribs ; through two of these, sharp fragments projected into the pleural cavity ; the third was merely a minute crack in the pleura. But I have never seen any widespread laceration of the pleura ; it does not split far and wide, but gives way just where the fragments are actually driven through it.

Injuries of the Vessels of the Chest Wall.

Wounds of the intercostal and internal mammary arteries are considered in a subsequent chapter ; for they are, in almost all cases, due to incision or laceration of the chest wall. But it is at least possible that one of these arteries should be wounded or cut across in simple fracture of ribs or sternum, as in the following cases [1] :

1. A man, aged 30, received a slight blow on the right side of the chest, and an hour later complained of pain extending from the lowest rib up toward the shoulder. There was no

[1] Turner, "Medical Times and Gaz.," 1860 ii., p. 607.

external bruise. He was admitted to Hospital, and four hours later fell into a state of collapse, with cold sweats, continuous vomiting, small pulse, 130, often imperceptible. He died in seventeen hours. *Post mortem*, no external sign of any injury. In the pleural cavity were 5 pints of blood, and the lung was collapsed. The only injury was a partial fracture of the inner aspect of the eighth rib, with slight abrasion, and a minute slit in the pleura. The intercostal artery itself was uninjured; the hæmorrhage must have come from a small branch of it running close to the opening in the pleura.

2. A case is reported by Gulliver, of fracture of the sternum, where both internal mammary arteries were torn. Death followed from extravasated blood pressing on the heart. Gurlt records a similar case.

I can find no further record of laceration of these vessels in simple fracture without external wound. Still, the possibility of it should be borne in mind, if one should have a case of fractured ribs with hæmothorax, but without any sign of laceration of the lung.

Injuries of the Lung.

The numerous and dangerous injuries of the lung that may attend simple fracture of ribs may be roughly divided according as they manifest themselves soon or late after the injury. Hæmoptysis, emphysema, pneumothorax, hæmothorax—these show themselves at once, or soon after the accident. Bronchitis, pneumonia, abscess, or gangrene, or hernia of the lung, come later.

But this division has no practical value, and the majority of the above lesions are discussed further in this book. We will here take only a general practical view of such cases as may best illustrate the character and extent of the danger to which the lung is exposed in fracture of the ribs.

And it is to be observed that these injuries are not, in most cases, due to direct driving inward of the fragments

of bone into the lung. The ends of a broken rib may just wound the surface of the lung, and cause emphysema or pneumothorax; and in severe comminuted fracture of the chest wall, as by a gunshot wound, pieces of bone may be forced right into the lung; but, as a rule, any deep laceration in simple fracture of ribs is due to the violence that broke the ribs, not to actual entry of the sharp fragments into the lung. The following two cases[1] will illustrate this fact.

1. A boy, aged 13½, was run over and admitted to Hospital. There was no loss of consciousness, no vomiting, no hæmoptysis. Two hours later, severe dyspnœa, breathing rapid, noisy, and painful: all over the right side of the chest there was amphoric sound, with metallic tinkling sounds. There was no sign of any fracture, and no emphysema. Venesection was practised. That night he suffered extreme oppression and restlessness; next day his respiration was 60, pulse 140. Venesection repeated; dry cupping over epigastrium. He became delirious, and died two days later. *Post mortem*, the outer surfaces only of the third and fourth left,and third right ribs were cracked, so that the ribs could be pushed a little way inward; their periosteum was not torn; the pleuræ were not injured. The right lung was lacerated in two places, the right pleural cavity contained 8 or 9 ounces of blood, and a quantity of air, and was covered with a soft thick false membrane.

2. A man, aged 24, run over, was brought four miles in a cart and admitted to Hospital. He was not much collapsed; there was no sign of fracture; no hæmoptysis; pain over the liver and in the epigastrium. Next day he was better, but still had severe pain in the same region, and two days later he was slightly jaundiced, and the urine was deeply stained with bile. On the fifth day he suddenly became much worse, with profuse sweating, intense epigastric pain, rapid laboured breathing, pulse intermittent, 130; and there were signs of air in the left pleural cavity, with extreme dulness over the lower part of the lung. Next day the pleura was punctured with a trochar and cannula. 'Just before the operation, metallic tinkling and amphoric resonance were

[1] Marjolin, quoted by Gurlt, *loc. cit.*; McDonnell, "Dublin Quarterly Journal," 1864, xxxviii., p. 205.

heard for the first time, leaving no doubt as to the existence of a wound of the lung.' More than a pint of blood was let out, with a large quantity of air. His relief was great, his pulse ceased to intermit, and he slept well. He gradually got weaker, and died with acute bronchitis of the opposite lung, ten days after the accident. *Post mortem*, heart and mediastinum displaced toward right side, diaphragm so pushed downward as to lie well below the costal cartilages; air, and at least 3 quarts of blood, in the left pleura. 'The left lung was lacerated in a terrible way, a large portion of it being nearly torn off. It appeared as if a part of the lung had been adherent when rent off by the shock.' There was no fracture of the ribs. 'About an hour or two before his death, some clots of blood were coughed up; but before that time no hæmoptysis occurred.'

These two most interesting cases clearly show that the lung may be fearfully lacerated even without fracture of the ribs; and that where the ribs are fractured, we still cannot decide the nature or extent of the internal injury. Indeed, we have no sign of any kind that can enable us to make a clear estimate of it. Hæmoptysis was absent in these two cases, and in a similar one of my own, which I give on page 44, beside others recorded by Erichsen and Morel-Lavallée. Hæmothorax is a surer guide, and will be considered later.

Still, the occurrence of hæmoptysis can lead us to a fairly accurate idea of what has happened. A slight degree of contusion or concussion of the lung, rather than actual laceration, is very common in these cases; as in an old man, lately under my care, who broke several of the upper ribs on the left side, near the axilla. His sputa were blood-stained for the first two or three days, then rusty, then normal, and no further trouble followed. 'In these cases, the lung is ecchymosed at the time of the injury, and the blood extravasated in its tissue gradually breaks down. At first, the sputa are of mucus untinged with blood; after some days, the patient

coughs up a small quantity of dark, coagulated, viscid blood—very different from the florid, frothy sputum of recent lung-wound; and the sputa may be tinged with blood for some time afterward. If the surface only of the lung is injured, the bleeding may be very slight. When it is abundant, the patient spits up large quantities of florid frothy blood, a considerable quantity of which may be swallowed and subsequently vomited. If it do not prove fatal, this bloody expectoration generally ceases, in a great measure, in the course of forty-eight hours, giving way to sputa of a rusty character.'[1] But in laceration of the lung by a heavy weight, as in these cases of fractured ribs, the torn vessels of the lung-tissue are less likely to bleed into the bronchial tubes than in cases of penetrating wound of the chest with a sharp instrument.

The following cases illustrate serious but not fatal laceration of the lung in simple fracture of ribs :—

1. A woman, aged 24, run over, was admitted to Hospital under my care, much collapsed, with fracture of two ribs on the right side of the chest, far back toward the spine; she was spitting blood rather freely, and loud râles were heard over that side of the chest. With complete rest, and careful nursing, she did well for a week; the hæmoptysis came gradually to an end, and she was beginning to sit up in bed. On the eighth day, she was more weak and ill, and had increase of pain in the side; temperature 102, respiration 50; signs of pneumothorax over front of chest; behind, signs of a circumscribed effusion. On the thirteenth day, an aspirating needle was put in at the fifth space, near the angle of the scapula, and 8 ounces of dark fluid blood were drawn off. This gave her great relief; but on the nineteenth day it was necessary again to aspirate, and this time the blood that was evacuated was mixed with offensive pus. A week later, I made a free incision, letting out 6 or 7 ounces of thin brown, turbid, offensive fluid, mixed with pus, and put in a large tube. No more fluid came during the operation, but a few hours later there was a profuse rush of it, soaking the bed. She did well; the tube was left out on the seventh day.

[1] Erichsen, "System of Surgery," ii., p. 829

2.[1] A man, aged 26, was kicked on the left side of the chest, and suffered fracture of the fifth and sixth left ribs. Forty-eight hours later, he began to spit blood, and was admitted to Hospital. On admission, he was 'coughing and bringing up venous blood continually.' Next day, he was restless and in a very bad way; temp. 103·4; 'expectoration profuse, and almost entirely made up of blood.' The following day, there was dulness up to the upper angle of the scapula, and, with the stethoscope put just below the nipple, air could be heard entering the pleural cavity from the lung. A week later, a swelling came below the nipple; it was aspirated, and a small quantity of blood-stained purulent fluid was withdrawn; incision, two days later, let out 4 or 5 ounces of pus. He made a good recovery.

3.[2] A boy, aged 16, run over, was admitted to Hospital with fracture of sixth, seventh and eighth right ribs just in front of their angles. Three hours later, he coughed up some blood, and next day 'was coughing up large quantities of blood'; general condition very bad, pulse 120, respiration 60, but temperature normal. On the ninth day the hæmoptysis had stopped; on the tenth he got out of bed without leave; on the eleventh the hæmoptysis returned, there were signs of fluid in the pleura, and he had a rigor; temperature 102, P. 140, R. 66. Next day he was aspirated, and 3 pints of blood-stained fluid were withdrawn. On the seventeenth day there were again signs of fluid, and above the level of the fluid there was tympanitic resonance, with amphoric breathing and metallic tinkling sounds. On the twenty-first he was again aspirated—a quart of blood-stained fluid; and again on the twenty-third—12 ounces of purulent fluid. Free incision was now made, and 1½ pints of purulent fluid was let out, with a quantity of air. This was followed by pneumothorax of the whole side. He made a good recovery.

These three cases give a vivid picture of serious but not fatal laceration of the lung in simple fracture of ribs. As one reads them, the question arises why incision was so long delayed. In my own case, there were two reasons: first, the patient was steadily gaining ground, in spite of the state of her chest; next, I was afraid that the ad-

[1] Hird, "Med. Times and Gaz.," 1878, ii., p. 514.
[2] Walsham, "Med. Times and Gaz.," 1884, i., p. 452.

ministration of an anæsthetic might cause the hæmoptysis to return. They also show clearly the need of absolute rest, very careful nursing, and so forth. It is possible that the hæmoptysis may be checked by subcutaneous injections of morphia, or by the careful use of ice to the side of the chest.[1] How common these cases are, is shown by Settegast's report, already quoted. Out of 20 Hospital cases of simple fracture of ribs, 3 had extensive emphysema, 3 traumatic pleurisy, 4 pneumothorax and hæmothorax, and 7 severe injury of the lung, giving rise to hæmoptysis, bronchitis, and 'œdema of the lung.' Out of 8 cases of simple contusion without fracture, 2 had traumatic pleurisy, 2 pneumothorax and hæmothorax, and 1 of these had 'several attacks of œdema of the lung.'

We have now to consider that form of pneumonia with bronchitis that is so perilous in cases of fractured ribs. The term 'œdema of the lung' is unsuited to it, and is best kept either for the acute general œdema of both lungs which may occur apart from any injury of the chest, or for that strange 'serous œdema,' with albuminous sputa (see the chapter on Pleural Effusions other than Empyema) which follows sudden release of a compressed lung by evacuation of a pleural effusion. The consolidation of a contused lung, some days after injury, is a true pneumonia, not a passive process. The following cases illustrate the character of this most dangerous condition:—

1. A man, aged 39, heavy, unhealthy, and a drunkard, was admitted to Hospital under my care, having fallen out of

[1] Bamberger recommends the following mixture:—Turpentine, ʒj; oil of sweet almonds, ʒj; mucilage of acacia, ʒiv; syrup, ʒiv; water to ℥v. A teaspoonful every half hour ("Journ. Amer. Med. Ass.," June 6th, 1891). See Dr. West's paper, quoted in the chapter on Tubercular Phthisis, for the whole subject of treatment of profuse hæmoptysis

a cart while drunk, and fractured four or five ribs on the right side ; he had also a scalp wound, and displacement of sternal end of right clavicle. He was unconscious, his breathing was stertorous, and there were signs of chronic bronchitis, with profuse muco-purulent sputa ; no hæmoptysis. Two days after admission, his temperature rose to 102, and his sputa were rusty ; next day there were physical signs of pneumonia of the left base, and he was delirious. He was now bled by the resident medical officer, to 8 ounces only. There was at once marked improvement, and he made a good recovery.

2. A woman, aged 50, was admitted to Hospital under my care, run over, having suffered fracture with depression of the third, fourth and fifth ribs on the right side, below the breast. There was also free bleeding from the vagina, and blood was oozing from the os uteri. The vagina was plugged ; the injured side of the chest was strapped. Her temperature on admission was subnormal, but next day it was 101 ; and on the third day there were signs of bronchitis. On the fourth day the temperature was over 103, and next day the sputa were rusty, and she was somewhat cyanosed. The following day there was dulness over the right side, with loss of vocal vibration, and she lay on this side ; respiration laboured, 52, temperature 102·2. Leeches were applied, but did no good. On the eighth day she was worse in every way : dulness over the whole right side ; loud râles, tubular breathing, 56, temperature 103. She died on the tenth day. Venesection was proposed in this case, but she was thought to be too weak to stand it.

It is hard to say whether pneumonia and bronchitis are or are not common in cases of simple fracture of ribs. To judge by Settegast's figures, they are common ; but Poland, out of 136 cases of fractured ribs, found only 28 complicated with internal injuries, and of these only 4 had pneumonia, none of whom died ; 3 others had 'extensive injury and severe inflammatory symptoms.'

I add another case, where the lung was lacerated, on account of the great temporary relief given by venesection.

A man, aged 45, heavy, gouty, and subject to bronchitis was admitted to Hospital under my care, having beer crushed by the capsizing of a heavy carriage. He suffered

fracture of many ribs on both sides, and bad compound fracture of the leg. Severe collapse, no hæmoptysis. On the third day his breathing became so rapid, and his pulse so rapid and violent, that he was bled, to a few ounces only; and again, that evening, to 9 ounces. He was immediately much relieved, and got some sleep; and as the first blood was flowing, he said, "Now I begin to feel more comfortable." But the relief was only for a time: he became delirious, with respiration 52, pulse 142, weak and not easily counted, and died on the fifth day after the accident. *Post mortem*, thirteen ribs were found broken, seven on one side, six on the other; there was severe laceration of the right lung, with hæmothorax. There was also a minute hæmorrhage into the left half of the pons Varolii, and some loss of power of the right arm was noted during life.

So far as I know, there is nothing in the literature of modern surgery as to the use of venesection in surgical cases. But, as regards the class of cases with which we are now concerned, there is abundant evidence that venesection may bring immediate relief, or may even, so far as we can judge, save the patient's life. Poland speaks thus of it: 'Venesection is employed, on rare occasions, for the relief of alarming chest symptoms, which threaten to terminate fatally by asphyxia; the chief indications for its use being increasing dyspnœa, oppressed circulation, engorgement of the lungs, and insufficient aëration of the blood, as exhibited by the dusky countenance, cyanosed lips, and hard pulse. In these cases it acts quickly and like a charm, and blood should be taken freely until the distressing symptoms are relieved, and the venesection repeated if they recur.' But he adds that out of his 136 cases, only 3 required venesection. Still, only 28 of the 136 had internal injury of any kind; we may therefore reckon that 3 out of 28, at least, were in urgent need of venesection.

Gurlt says: 'We cannot stop short at bandaging, in cases of severe fracture of ribs with hæmothorax, pneumo-

thorax, emphysema, hæmoptysis, and so forth. We have to face the immediate danger of death. In almost every case, we must bleed the patient freely. In many of these complicated cases, when once we have got the patient past the stage of shock, a free venesection will not only relieve the dyspnœa and the oppressive feeling of suffocation, but will also stay the hæmorrhage from the lungs. The flow of blood must be stopped as soon as it has done definite good; but it must in some cases be repeated, or local depletion must be used.'

And Solly, speaking of similar cases, says: 'The most important lesson which these cases have appeared to me to teach has been the extreme value of depletory treatment generally, and more especially of blood-letting.'

Doubtless the use of venesection in internal injuries of the chest was in former days indiscriminate and often harmful; but he who will read the essays on venesection from a medical point of view, by Dr. Bowditch[1] and Sir B. W. Richardson,[2] and, above all, Dr. Pye-Smith's paper in the Transactions of the Medico-Chirurgical Society for 1891,[3] will find proof that in the surgery of the chest cases now and again occur where it is the clear immediate duty of the surgeon to bleed the patient.

Finally, is there any reason to think that, in a case of simple fracture of ribs with internal injury, the surgeon could ever be justified in attempting to expose the lung and arrest the hæmorrhage from it? There is abundant proof, in the chapter on Penetrating Wounds of the Chest, that this may be done, and the patient saved from death,

[1] Massachusetts Medical Society, June 1871.

[2] Opening Address, Medical Society of London, 1868.

[3] Dr. Pye-Smith gives notes of 49 cases treated by venesection. The result, in 31 cases, was marked relief. Of the 49 cases, 13 were cases of bronchitis, several of which were complicated with some degree of lobar pneumonia.

in cases where the lung has been cut by a deep incised wound. Can we hope to save life by operating for laceration of the lungs in simple fracture of the ribs?

We may exclude the possibility that the blood in the pleural cavity in such cases has come, not from the lung, but from a torn intercostal artery. I know only one instance where this happened (page 37). If we did get a case of simple fracture of ribs, with extensive hæmothorax, but without hæmoptysis, and without pneumothorax, we might suspect the blood came from a torn intercostal artery, but we should probably find it was from the lung after all.

The fracture cannot tell us either the situation or the extent of the laceration of the lung. If this be slight, the hæmorrhage will not be fatal. If severe, the risks of the operation, and the difficulty of dealing with a half-shattered lung hidden in and beneath a mass of adherent clot, in a patient already enfeebled, feverish, and ill-suited for an anæsthetic, would be enormous. I can find no record of any such attempt, and it is hardly possible that it would be justified.

Hæmothorax, Pneumothorax, and Emphysema.—These lesions are fully considered in other chapters, and in that on Wounds of the Lung; we have here only to note their occurrence in cases of simple fracture. Cases of hæmothorax have already been given. In such, there is usually air as well as blood in the pleural cavity (hæmopneumothorax), and it is often followed by inflammation of the pleura, tending to suppuration. But, according to Pagenstecher,[1] hæmothorax does not of itself set up this inflammation: the two things are independent, and are both due to the original injury.

---

[1] "Beiträge z. Klin. Chir.," 1895, xiii., 1, p. 264.

The two following cases,[1] one of hæmothorax and emphysema, the other of double hæmothorax, followed by thrombosis, are of great interest.

A man, aged 45, was struck by the shaft of a cart on the left side of the chest, toward the scapula ; the fifth, sixth and seventh ribs were driven inward. Over them, between scapula and spine, was a large emphysematous swelling, which rose and fell with respiration ; and there was general emphysema of the whole side down to the hip. He found relief by lying with his face downward, and his arms under him. He was in much pain, with cold hands and feet, feeble pulse, and difficult breathing. An incision was made into the swelling, a quantity of air was let out, air was heard escaping from the lung, and with the finger a broken rib was felt pressing on the lung. When his arm was put behind his back, the fragment was reduced, and he felt relieved. He was now laid on his back, and nearly a pint of blood escaped through the incision, to his great relief Two hours later, there was more bleeding from the wound, and again he had to lie face downward to get any rest. Next day he was again turned over on his back, and a pint of blood-stained fluid escaped. The incision remained open for many weeks. He finally made a complete recovery.

2. A man, aged 29, had his chest crushed in a railway accident. He suffered fractured ribs, dyspnœa, pain on breathing, and cough, and was cyanosed ; no hæmoptysis ; signs of double hæmothorax. Two days later there was marked improvement, and the blood was beginning to be absorbed. By the twelfth day, the right side was everywhere resonant ; the left side was dull below a line drawn from the nipple to the fifth dorsal spine. On the nineteenth day, he was suddenly seized with severe dyspnœa, and next day the whole of the left side was dull, breath-sounds feeble. heart pushed over to right border of sternum ; pain in the left arm, œdema of its upper part ; thrombosis of the brachial veins. Three days later came œdema and extreme tenderness over the left external jugular vein. He slowly recovered. The veins over the left side of the chest were still dilated when he left the Hospital eight weeks after the accident.

This sudden effusion on the nineteenth day cannot have been blood : there was no sign of profuse internal hæmorrhage.

---

[1] Norman, "Prov. Med. Journ.," 1844, vii, 29, quoted by Gurlt. Pagenstecher, *loc. cit.*

It must have been due to thrombosis involving the left innominate vein, probably set up by some injury of the veins at or near the fractured ribs.

Pneumothorax may follow contusion of the chest, even though one cannot find any clear evidence of fracture. In two cases lately at the Metropolitan Hospital, under the care of my colleagues, there was well marked pneumothorax, but no sign of fracture. The patients were both young children, who had been run over. They both made a rapid recovery, without active treatment. The following cases [1] illustrate the same fact:—

1. A man, aged 22, was admitted to Hospital, having fallen 30 feet: scalp wound, concussion, no fracture of ribs or sternum. Next day it was found that the left side of the chest was hyper-resonant, the breath-sounds on this side very feeble, the heart pushed over to the right side. Ten days later, the hyper-resonance was less marked, and now there was dulness at the base, and a well-marked splashing sound. This sound could still be heard four or five weeks after the accident. After recovery, the left side remained slightly contracted.

2. A boy, aged 6, was admitted to Hospital, run over, but without fracture. Next day he was feverish, and lay moaning, with closed eyes; breathing very rapid, and chiefly abdominal. There was general hyper-resonance of the left side of the chest, but some dulness over the base of the lung behind; the area of cardiac dulness was absent, and the heart's impulse was most marked in the epigastrium. He made a good recovery.

In such cases as these, the danger to life may be immediate, demanding instant treatment. A boy, aged 13, run over, was admitted to Hospital with intense dyspnœa, quick weak pulse, lips blue, skin cold and livid; the left side of the chest was an inch and a quarter larger than the right side, and hyper-resonant; the heart was displaced downward and to the right. Puncture was now made with a trochar and cannula in the fifth space. Air hissed

[1] Butlin, "St. Bartholomew's Hosp. Reports," 1875, p. 255.

out, his breathing was relieved, his heart came back into place. He made a good recovery.[1]

There is usually effusion of blood as well as of air into the pleura in these cases. Emphysema also is often present. And one must bear in mind the possibility that a severe crushing of the chest may cause extensive rupture of the diaphragm, and through the rent thus made, the bowels may ascend into the pleural cavity, and by their tympanitic note may simulate pneumothorax. Such an accident is reported by Larcher; and the following case[2] is another example of it. A man, suffering from severe contusion of the chest, had marked hyper-resonance of the left side, loss of vocal vibrations, almost complete loss of breath sounds, and displacement of the heart over to the right side. The case thus appeared to be one of pneumothorax, and a puncture of the chest was made, but with no definite result either good or bad. The patient died of other injuries two days after the accident. *Post mortem*, there was extensive laceration of the left half of the diaphragm; and the stomach, spleen, and transverse colon had ascended into the left pleural cavity.

Emphysema is not common in cases of simple fracture of the ribs. Out of all those that have been under my care, I can remember only a very few where emphysema was noted; nor, if it does occur, will it probably spread far, last long, cause pain, or need treatment. But of course, if one takes only those cases of fractured ribs that are so serious as to be admitted to Hospital, emphysema is not uncommon. Poland noted it in 19 cases out of 136, Settegast in 3 out of 20. Hernia of the lung also may follow simple fracture of ribs without external wound.

---

[1] Curling, "Med. Times and Gaz.," 1867.
[2] Butlin, "St. Bartholomew's Hosp. Reports," 1875.

1. A man, crushed between a cart and a wall, suffered fracture of the third, fourth and fifth right ribs near the sternum; and this was followed by the appearance of a reducible swelling at the seat of the fracture. He lived many years after the accident. After his death, from other causes, at 62, the swelling was found to be a true hernial sac, containing a considerable portion of the lung, wholly unaltered.

2. A man, aged 20, was crushed by a heavy weight falling on him, and suffered fracture of the third and fourth costal cartilages of one side. Here a swelling appeared, the size of one's fist, which rose and fell with respiration; there was also slight emphysema. He died three days after the accident. *Post mortem*, it was found that the intercostal muscles were so badly torn that a true hernia of the lung had taken place through them.

Two similar cases are recorded by Wahl and Huguier. In one, there was fracture of the second and third ribs; the hernia first occurred some time after the accident, during a severe fit of coughing: it was very tender and painful. In time it receded, leaving a small hernial ring about a third of an inch in diameter. In the other case, the fractured rib failed to unite, and could be felt lying in front of the hernia, and moving with it.

Injuries of the Heart.[1]

It is more correct to speak of injury than of wound in this connection, for though it is possible, with simple fracture, for the heart to be ruptured by the violence of the accident, or pierced by a sharp fragment of rib or costal cartilage or sternum, yet, in the majority of those cases that do not at once end in death, the harm done to the heart is very slight and very obscure.

I need only illustrate injury of the heart, in simple fracture, by the following cases:—

[1] Rose, Herz-tamponade, "Deutsch. Ztschr. f. Chir." xx, 1884, p. 329. Heidenhain, Ueber die Entstehung von Organischen Herzfehlern durch Quetschung des Herzens. "Deutsch. Ztschr. f. Chir.," 1895, xli, 4 and 5, pp. 286—329.

ROSE'S CASES OF INJURY OF HEART

("Deutsche Ztschr. f. Chir.,"

1. WITH INJURY OF

No.	OTHER INJURIES.	SIGNS AND CONSEQUENCES OF THE WOUND OF THE HEART.
1	Wounds of lip and tongue. Fracture of upper jaw.	The heart sounds had a metallic tone, which lasted two days. Later, pericarditis.
2	Fracture of both clavicles.	Partial pneumopericardium. First a friction sound, then tympanitic note over heart, with metallic ring of heart-sounds. Later, a rough friction sound behind the sternum.
3	Scalp wound, concussion, bruises, fracture of humerus.	Total pneumopericardium (total abolition of cardiac dulness, later tympanitic note with metallic splashing sound synchronous with heart.) Plastic pericarditis. Adhesion of wounded heart to opening in pericardium.
4	Scalp wound. Fracture of pelvis.	Heart sounds hardly to be heard. Pulse very rapid and intermittent. Partial pneumopericardium, recurrent. (Tympanitic note, cracked-pot sound, metallic ring, synchronous with heart beat; metallic heart-sounds, metallic friction sound.) Pericarditis with effusion.
5	Severe concussion. Compound fracture of nasal bones. Lacerations of the intestines.	Total pneumopericardium (metallic heart sounds, irregular pulse). Hæmopericardium.
6	———	Partial pneumopericardium. (Tympanitic note, musical murmur.) Hæmopericardium. Pericarditis.

2. WITHOUT INJURY

7	Fracture of base of skull, simple fracture of both femora. Fracture of left humerus.	Pulse very rapid, intermitting, and irregular. Pericarditis. Gangrene in both lower limbs.
8	———	No signs observed, at the time, of any injury of the heart.

IN SIMPLE FRACTURE OF RIBS.

xx., 1884, 329—410.)

LUNG—6 CASES.

SIGNS AND CONSEQUENCES OF THE WOUND OF THE LUNG.	COMPLICATIONS.	RESULT.
No very marked signs, but persistent dyspnœa	——	Recovery.
Surgical emphysema. Pneumopericarditis. Pleurisy with effusion.	——	Recovery.
Hæmoptysis, dyspnœa, hæmothorax, pneumothorax, surgical emphysema.	Delirium tremens (third attack). Fat embolism of lungs.	Death.
Hæmoptysis, orthopnœa, contusion of lung, pneumothorax, surgical emphysema, pleurisy with effusion.	Chronic delirium tremens.	Recovery.
Hæmopneumothorax. Surgical emphysema.	——	Death.
Pneumopericardium. Pleurisy with effusion.	——	Recovery.

OF LUNG—2 CASES.

———	Double amputation above the knees.	Recovery.
———	——	Death a year later with pericarditis & ascites.

These cases raise a very important question. What are the ultimate results of slight injury to the heart, not fatal, in cases of contusion or simple fracture of the chest wall?

The best answer that I can find to this question is given in Heidenhain's essay (1895) on 'The Occurrence of Organic Defects of the Heart after Contusion.' He quotes a great number of cases, and draws the following conclusions from them :—

1. There is evidence to show, that a contusion, without external wound, and with or without fracture of the ribs, may cause slight injury of the walls of the heart, which yet does not prove fatal. It may be supposed that in such cases there may be permanent impairment of the action of the heart.

2. A contusion may, as has been proved by many positive observations, cause laceration of the valves of the left side of the heart. No injury of this kind has hitherto been noted on the right side of the heart.

3. From these lacerations of the valves of the heart by external violence we must distinguish that more common form of laceration, which sometimes occurs also on the right side of the heart, from internal strain, through great increase of the blood pressure during very violent exertion.

4. Lacerations of the valves can of themselves only bring about impairment of the action of the valves.

5. Those rare cases, in which a contusion over the heart has been followed by stenosis of the valves, can be explained only by later inflammatory changes in the valves. So far as our knowledge goes at present, we must believe that chronic endocarditis is at work to produce them.

CHAPTER V.

EMPHYSEMA.

CASES have already been given in which emphysema was one among other troubles; and it is so common, and sometimes so dangerous to life, that we may now consider it at some length. It has at all times held the attention of surgeons, and its conditions and course have been made the subject of much experimental work.

As a rule, it may be easily recognized, even when not well marked, by the slight uplifting and pitting and increased tension, without inflammation, of the skin thus affected, and by the strange soft feel of fine crepitation, as if one were touching a lung, or a piece of absorbent wool, or a limb affected with acute gangrene. It is easily recognized by this peculiar feel; but it is not very common. Certainly there is no need to fear it as Hennen did, who says, 'When I first entered on military surgery, the fear of emphysema actually haunted my hours of repose.' In that wonderful monument of clinical work, The History of the War of the Rebellion, it was noted in 38 only, out of 8,715 cases of penetrating wound of the chest. In simple fractures, I have very seldom seen it, and have never seen trouble come of it. Such cases as the following[1] must be rare indeed:—

1. A boy, aged 9, was run over. Ten minutes later, on admission to Hospital, there was already general emphysema,

[1] Bastian: "Lancet," 1860. Bramann: "Verhandl. d. Deutsch. Ges. f. Chir." 1893, p. 114.

extending as low as the knees. Pneumo-thorax, marked on right side, slight on left side. No sign of any fracture. He was restless, with dyspnœa, and rapid feeble pulse. Ten minutes later, he almost ceased breathing, and his pulse could hardly be felt. Immediate puncture of the right side let out a great quantity of air, and gave him relief; but he died about half an hour after the accident. *Post mortem*, no external sign of injury, no collapse of the lungs, a few ounces of blood-stained fluid in the pleuræ. 'On inflating the right lung, we found a minute laceration toward the posterior aspect of the apex; near it, the second right rib was fractured close to the tubercle, and a splinter had cut through the pleura.'

2. A man, aged 19, run over, suffered fracture of third right rib. In three hours, there was emphysema of head and neck, trunk, and upper limbs. In the course of the next few hours, it increased enormously, so that the whole body was blown up like an air-ball; face dusky and featureless, eyes closed, eyelids hugely swollen. That evening, the emphysema had reached his feet. He suffered dyspnœa, oppression, and restlessness; face cyanosed, pulse rapid and feeble, respiration 54. He was plainly in imminent danger of death. At the seat of fracture, one could hear a whistling sound, as of air passing through a narrow opening. The surgeon now incised the chest and resected two inches of the fourth rib and opened the pleura. A quantity of air whistled out. The lung was collapsed. Air could be heard issuing from it at each inspiration, but no wound could be seen, and he was not in a state that allowed prolonged examination. A valvular tube was inserted, and the emphysema became less. Next day, it was worse again, and the tube, having become blocked, was replaced by a syphon-tube. The emphysema was all gone in a week; the tube was left out on the tenth day. He made a good recovery.

But even a less 'fulminating' attack of emphysema may cause grave distress.[1]

1. A man, aged 66, fell and broke the fourth and fifth right ribs in the axillary line. He suffered great oppression, hæmoptysis, breathing rapid and shallow, slight emphysema. Next day, the emphysema had spread over the shoulder and

[1] Gurlt, loc. cit. pp. 219, 241.

the whole side of the chest. On the fifth day, as the emphysema, dyspnœa, and oppressive feeling of suffocation were all worse, an incision was made into the chest, and air and blood escaped, to his great relief. A valve was laid over the incision. He made a good recovery.

2. A man, caught between two railway wagons, suffered multiple fractures of the second to sixth right ribs. On admission to hospital, he was badly collapsed, and was spitting blood. Over the seat of fracture was a large emphysematous swelling rising and falling with respiration, and under such high pressure that the emphysema spread over more than half of the body. Scarification was used where it was worst; bandages were applied, and a truss so arranged over the shoulder as to keep the fragments in better apposition.

3. A man, aged 56, was crushed over the chest, three ribs on the left side being fractured and driven far inward; the soft parts over them contained air, and flapped in and out with respiration. Emphysema had begun round the seat of injury. He was bled and bandaged, and got great relief, but only for a few hours. The emphysema spread rapidly up into the neck, over the whole left side, and down the arm as far as the elbow, covering, next day, the whole of the chest; but here it stopped, and in about a fortnight was wholly absorbed.

In contrast with these cases, which recovered, save one where death from shock occurred half an hour after the accident, I place the following,[1] in which it seems that nothing was done to avert death. A man, aged 60, run over, suffered fracture of the fourth and fifth left ribs. General emphysema followed, and he died, slowly suffocated, on the fourth day. *Post mortem*, there was emphysema of the whole surface, save only the palms and soles. The opening into the pleural cavity was so small as to be only just visible. There was a very small superficial laceration of the lung, but no blood in the pleural cavity.

---

[1] Boyer, "Traité des Maladies Chirurgicales," vii, 286.

These six cases illustrate the occurrence of severe emphysema after a simple fracture of the ribs. As to its relation to penetrating or gunshot wounds of the chest, one thing is certain: that it is not common, and is, on the whole, more likely to follow a wound with a knife or a bayonet than a gunshot wound: either the former is more often valvular, or the latter bruises the air-vesicles and bronchioles, and thus prevents the escape of air. Most authorities are agreed as to the rarity of emphysema after gunshot wounds. In the American War, it was noted in only 38 out of 8715 cases of penetrating wound of the chest. 'The plain fact is, that it does not occur in one case in fifty' (Hennen). 'According to observations made in the wars of the last twenty years, it appears to follow injuries of the chest in only one out of two hundred cases' (Neudörfer). There is no need to quote many cases of emphysema in penetrating wound of the chest; but mention must be made of the celebrated case published by Larrey.[1]

A young soldier received a sword-thrust through the fourth right intercostal space. In a few hours, there was general emphysema. 'So severe was it, that all the prominences and hollows of the surface of the body were almost obliterated; he had become a mere tense, inflated, resonant, crepitant mass.' His neck was so swollen that his head seemed continuous with his shoulders. Mouth, nostrils, and eyes were closed up. The scrotum was the size of a child's head; he suffered frightful pain and dyspnœa. Larrey at once applied firm pressure over the wound, and made two incisions, one near the trachea to relieve pressure here, and one over the sternum. He also cupped him repeatedly, both over the incisions and elsewhere. In two hours he was much relieved. Next day, the cupping was repeated. He made a good recovery.

It is evident that for the production of severe emphy-

[1] "Clinique Chirurgicale," 1832, ii, 195.

sema,[1] the lung must be neither inactive nor collapsed, the wound in it small, and the whole injury such that the air can be forced far and wide by each stroke of the lungs, into the loose areolar tissue. The size of the wound of the lung is, indeed, in inverse proportion to the extent of the emphysema. A specimen in the College of Surgeons' Museum, from a case of fatal emphysema, shows a sort of pin-prick in the lung, only just admitting a bristle. Dr. Ewart[2] records a case where puncture of the lung with a trochar, only $\frac{1}{18}$ inch in internal measurement, in search of pus, was followed by fatal pneumothorax; and in such a case, where pneumothorax is, emphysema may be. Dr. Theodore Williams[3] records a case where simple puncture of a tubercular cavity was followed both by pneumothorax and emphysema. Dr. West[4] records a case where aspiration of pneumothorax was followed by emphysema of the whole side of the chest.

Though most authorities are agreed that extensive emphysema is more often talked about than seen, others declare it to be common. Larrey said that the majority of penetrating wounds of the chest are followed by more or less emphysema. And in our war with the Maoris, out of twenty-three penetrating wounds

---

[1] For a full understanding of the causes and treatment of emphysema, we have, as our guides, The History of the War of the Rebellion, the monographs by Dr Champneys in volume LXVIII of the Medico-Chirurgical Society's Transactions, and Bramann's paper on the treatment of general emphysema, in the Transactions of the German Surgical Association for 1893. To the teaching of these authorities I add some scattered notes from other sources.

[2] "Medical Society's Trans.," 1890, xiii, 56.

[3] *See* Truc, "Chirurgie du Poumon," 1885.

[4] "Clinical Society's Transactions," 1884, xvii, 56.

carefully noted, emphysema occurred in six. Still, the weight of authority is against Larrey. Severe emphysema is rare because, in most wounds of the lung, the conditions for a perfect valve are absent, or the lung is bruised or lacerated, not clean cut; or it is collapsed; or the pressure of air or of blood in the pleural cavity prevents the escape of air. Again, a very small wound of the lung, such as would be most likely to cause emphysema, is rapidly sealed over, unless it is held open by old pleural adhesions. König,[1] from numerous experiments, found that even the removal of large pieces of the lung, without subsequent suturing of the gap, was not enough to cause severe emphysema. In a couple of hours the lung was sealed over and began to expand again, and the air that had escaped under the skin began to be absorbed. He is of opinion that no usual form of wound of the lung, either accidental or experimental, can produce general emphysema, unless, at the place where it is inflicted, there are old adhesions between the lung and the pleura; and he has been able to assure himself of the presence of these adhesions in more than one *post mortem* examination.

A further reason against the wide extension of emphysema lies in the resistance of all living tissues to invasion. Air under the skin is an irritant, a foreign body. It is easy to drive air under the skin of a dead animal, but living areolar tissue can to some extent defend itself, as we see when blood is effused under the scalp, or urine into the perinæum. With each stroke of the lungs, moreover, the pressure must be exercised over an increased body of air, and become weaker at any one point; the advance of the whole mass of air must be slower, and

[1] *See* discussion on Bramann's paper, *loc. cit.*

more easily resisted. It is suggested by Dr. Champneys, that general emphysema occurs only in those whose areolar tissue is especially loose, or unable to withstand the invasion that has suddenly assailed it.

It is certain that emphysema does occur without pneumothorax; and that it is not of itself proof that the lung has been wounded. (1) Slight emphysema may follow a non-penetrating irregular wound of the soft parts, the outside air being drawn by the movements of respiration into the loose areolar tissue; this has been observed in wounds opening the axilla. (2) Emphysema without pneumothorax may be due to old adhesions at the seat of injury, between the lung and the pleura. (3) Emphysema may be due to an extra-pleural laceration at or near the root of the lung, whence the air passes into the anterior mediastinum, up into the neck beneath the deep cervical fascia, and so reaches other parts of the body.

In those rare cases of very extensive emphysema, without pneumothorax, where careful *post mortem* examination has failed to find any evidence that the surface of the lung was wounded, this third explanation is the only one possible. The occurrence of laceration at the root of the lung would be favoured by extreme tension (deep inspiration) at the moment of the accident. And Dr. Champneys has proved, by a very important series of experiments on the dead body, that in life the anterior aspect of the root of the lung is just the part that is least able to withstand increase of the internal pressure.

It is this form of emphysema that may occur during the pains of labour: but it is not likely to extend far. The following case may be worthy of note:—

A primipara, aged 22, toward the end of her labour, exclaimed that she could not open her eyes or breathe, and did

not know what had come over her. 'Her face was very much swollen; it pitted deeply, and crepitated on pressure. Her neck was puffed up to double its natural size, and the skin covering her chest became a completely and rather tightly filled bag of air. However, labour went on, and about two hours later she was delivered of a healthy child.' A fortnight later, the emphysema had all disappeared, except a trace of it on the right side of the face.' [1]

The terrible oppression, dyspnœa, and prostration, which occurred in some of the above cases, were plainly due to the pneumothorax, not to the mere presence of air under the skin. But there is one result of emphysema, noted by Litten,[2] which is of interest. He found on repeated occasions, in cases of emphysema from various causes, that the urine contained crystals of calcium phosphate, of a peculiar wedge-like shape, grouped together by their pointed ends; and he was able to produce these by inducing emphysema of the skin of rabbits. The formation of these crystals does not depend on the character of the gas used for producing the emphysema; and the same crystals have been noted in the old varnishing experiments. They must, therefore, be due to some loss of function of the emphysematous skin.

Finally, we come to the treatment of emphysema. Two things are certain: first, that emphysema tends to get well of itself; next, that the danger of death is not so much in the emphysema, as in the pneumothorax with which it is associated. Still, if the emphysema is of great

---

[1] Pratt, "Dublin Quarterly Journal," 1864, xxxviii, 249. Similar cases, but not quite so severe, are given by Morel-Lavalleé, "Bull. Soc. de Chir," 1847, p. 89. Riedinger quotes the case of a cornet-player, who habitually, when he played hard, had a transient attack of emphysema of the hypogastric, inguinal, and scrotal regions.

[2] "Verhandl. d. Congress f. Inn. Med." 1885–86, p. 417.

tension, causing distress and sharp pain, something must be done, and two or three short incisions are better than a large number of small punctures. Tight bandaging is unbearable; ice to the wound is useless. The relief of the pneumothorax will be considered in the next chapter.

CHAPTER VI.

PNEUMOTHORAX.

We come now to ground that belongs rather to medicine than to surgery, not only because any destructive disease of the lung may be the cause of pneumothorax, but also because there are many problems in pneumothorax—mechanical, chemical, and physiological—as to intra-pleural pressure, absorption of gases, tension of the lungs, and so forth, which do not belong to surgery. He who would study the scientific aspects of pneumothorax, must go to the writings of Dr. West, Dr. Ewart, and Dr. Douglas Powell. Here, we are concerned only with its surgical side.

We may therefore begin with cases[1] of pneumothorax due to disease, but in need of surgical treatment.

1. A girl of 15, with tubercular phthisis, was admitted to Hospital on the 25th of May. On the 4th of July, early in the morning, she awoke shrieking with pain in the left side. Her face was pale and sunken; pulse 140, respiration 36. The heart was beating under the right nipple, evidently displaced by pneumothorax of the left side. The chest was at once punctured with a fine trochar and cannula, and air was let out, but in no great quantity. She had no return of her acute distress, and died ten days later. *Post mortem*, a tubercular cavity in the upper lobe o the lung had opened into the pleura.

2. A man, aged 41, was admitted to Hospital with tubercular phthisis, and pneumothorax of the left side. Two days after admission he was seized with dyspnœa, and his distress became so great that a puncture was made into the left side of the chest; a large quantity of air escaped, mixed

[1] Cayley, "Clin. Soc. Trans.," xvii., p. 52; Ewart, "Med. Soc. Trans.," xiii., p. 56; Andrew, "St. Bart. Hosp. Reports," xiii., p. 215.

with a little non-offensive pus. He gained great relief, but died suddenly three days later. *Post mortem*, there were found tubercular cavities in both lungs. The left pleura was much thickened, and contained air, and about a quart of pus. The lung was collapsed; on its posterior aspect, close to the root, and a little above it, was a small perforation leading into a cavity.

3. A man, aged 35, was admitted to Hospital with tubercular phthisis, and pneumothorax of the left side. He was suffering from dyspnœa, and unable to lie down; the heart was displaced to the right side. The dyspnœa had come on so gradually that he could not give the date when it began. Three days after admission, having suffered restless nights with fever, delirium, and absolute inability to rest lying down he was aspirated, and gained considerable relief. The heart came back part of the way to its normal position. But next day it was again displaced; and the following day he died. *Post mortem*, the left pleura was distended with air, and contained a little clear fluid. The left half of the diaphragm was much displaced downward; the lung was collapsed. A narrow sinus was found, tracking through adhesions, opening into the pleura from a cavity in the lung.

4. A man, aged 24, after some weeks of attendance as an out-patient with symptoms of phthisis, was suddenly seized one evening with severe pain in the right side, and dyspnœa. He was admitted to Hospital at once, and next day a large quantity of air was drawn off with the aspirator. This air, or rather gas, was found to extinguish a lighted taper at once, but contained no large excess of carbonic acid as compared with atmospheric air. He was relieved, and refused to stay in Hospital. Four days later, he was again admitted, with some air still in the pleura, and a good deal of emphysema, extending as low as the right inguinal region. The whole mass of air, both in the pleura and under the skin, was absorbed (without pleural effusion) in about six weeks. More than a year later, the signs of phthisis were still in abeyance, save for a very slight hæmoptysis, and he was in his usual health, and not losing flesh.

5. A girl, aged 14, was admitted to Hospital with typhoid fever. The case was a very serious one, with delirium, high fever, albuminuria, and bronchitis. On the 9th of May, she complained of severe pain in the right side of the chest; on the 11th there were pain, tenderness, and a friction-sound with fine crepitant râles; on the 13th she had a serious attack of dyspnœa, with prostration; on the 15th the signs

of pneumothorax were well marked; on the 16th she had intense dyspnœa, and seemed to be dying; and on the 18th had a similar attack. After this, she began to improve, but the pneumothorax remained unabsorbed; on the 25th, therefore, her side was punctured, and a quantity of air was let out. 'This gave considerable relief to the dyspnœa, but produced no alteration in the physical signs.' A second puncture was made two days after the first. A fortnight later, the pneumothorax was all absorbed, and she was convalescent.

These instances clearly show the surgical aspect of some cases of pneumothorax from disease. Among the diseases giving rise to it, tubercular phthisis is by far the most common; indeed, West says nine cases out of ten are due to it.[1] Other causes, apart from wounds of the lung, are the rupture of an emphysematous vesicle on sudden exertion or violent coughing, the breaking of an empyema into a bronchus, and advanced abscess or gangrene of the lung. A few cases also seem to show that a severe strain may cause slight laceration of the surface of the lung and pneumothorax, even though the lung be healthy, or, at all events, free from any active disease. Case 4, of pneumothorax in typhoid fever, 'was probably due to the breaking-down of a pulmonary embolism, from thrombosis of the right cavities of the heart.' A similar state of the heart is shown by Dr. Drewitt to explain the occurrence of gangrene of the lower limbs in certain cases of typhoid.

It is to be noted that pneumothorax is absent in those curious cases in which a sharp foreign body, such as a head of grass or a stalk of corn, swallowed or drawn into the air-passages, has very slowly worked its way out through one of the intercostal spaces. Two such cases

[1] Habershon notes that out of 1,375 *post-mortem* examinations of cases of phthisis (Brompton Hospital, 1885—1896), pneumothorax had occurred in 114, about 8 per cent.—*The Hospital, April 11th*, 1896.

are published by Mr. Godlee[1]: in one, a head of grass, forty-three days after it had been swallowed, escaped through the sixth left intercostal space, three inches from the spine; in the other, a similar piece of grass, fourteen days after it had been swallowed, escaped through the ninth left space near the angles of the ribs; it had a distinct fæcal odour. But in cases like these, if cough, hæmoptysis, pleurisy, and pneumothorax are absent, it is probable that the foreign body has not really traversed the lung.

As regards the treatment of pneumothorax arising from disease of the lung, it should be noted that often its onset is not so sudden, and its consequences not so serious, as in some of the cases quoted. 'In some—latent pneumothorax—the initial symptoms are slight, or even entirely absent. To a bed-ridden patient, with advanced phthisis, it matters little whether a lung be useless on account of phthisis, or because of the collapse of the lung which results from the pneumothorax.' Again, many cases have been recorded where in a short time the air was all absorbed, and the lung restored to its full strength. 'Fluid follows the pneumothorax; the air is absorbed, and the case becomes converted into one of pleuritic effusion, from which recovery may take place in the usual way'; or the air may be absorbed even without effusion of fluid.[2] Again, it is useless to draw air from the pleura

[1] "Clin. Soc. Trans.," xv., p. 156. Dr. Good ("St. Bart. Hosp. Rep.," 1891) gives the case of a child, aged 5, where the grass escaped three inches below the axilla: it caused some suppuration within the chest, with coughing up of pus, but no pneumothorax.

[2] See a case published by Dr. West, "Clin. Soc. Trans.," 1884, xvii., p. 56, with a collection of 23 similar cases. The causes of the pneumothorax, given in 18 of the 24, were as follows: phthisis, 4; probably phthisis, 4; rupture of emphysematous vesicle, 5 (not all certain); over-exertion, 2; external injury, 3. Out of 15 of the 24, in which the sex of the patient was given, only 1 was a woman.

till the opening in the lung is soundly healed. And it is possible that a too vigorous use of the aspirator might even re-open a healed spot in the lung, or excite latent mischief to become active. Finally, there is reason to believe that in some cases of tubercular phthisis, with slight effusion, the presence of this moderate amount of air or fluid tends to check the advance of the disease.

Thus the need for surgery in cases of pneumothorax from disease is not so evident as may at first sight appear. But if we cannot hope to do much good in advanced phthisis, yet in a case of rapid oppressive pneumothorax from any cause we may give great relief and may even avert death. We cannot determine how long the lung will hold out before it collapses under the pressure of the effused air; we cannot be sure that some sudden fit of coughing, or straining during evacuation of the bowels, may not pour a further quantity of air into the pleura, and bring the patient into immediate danger of dying. The perforation in the lung is, in many cases, minute, valvular, and soon healed. The puncture is in itself a very small thing, and of course no anæsthetic should be given. Except for one case where it was followed by emphysema, I can find no evidence that it can do harm: and a simple trochar and cannula may do as well as an aspirator.

'For the relief of the dyspnœa *immediately* after the onset of pneumothorax, aspiration would seem to hold out but a slender chance of usefulness; it is hardly possible that *within a delay of a few hours* any notable change should have taken place in the abnormal passage and orifice. Nevertheless, in some cases, the attendant circumstances may have become less unfavourable, as, for instance, where severe strain was the immediate cause of the accident. . . . . If the patient should

experience no relief; if no decided return of the heart can be made out; if, while the air pump is being used, the stethoscope, applied to the upper part of the chest, should transmit to the ear a loud sound of in-rushing air, the operation may be abandoned as useless, and not be renewed for a long time, if at all. . . . . In every case it should be followed by absolute rest, and by every available means for the avoidance of cough.'

With regard to these rules given by Dr. Ewart,[1] the first and fourth of the cases that I have quoted show that puncture, even a very few hours after the onset of the pneumothorax, may yet not be in vain. And the deficiency of oxygen in the gas withdrawn in the fourth case gives us another test, in addition to those given by him, by which we may judge whether the perforation in the lung is closed or open.

I think that if one reads the literature of pneumothorax due to disease, he will come to the opinion that a good many cases are recorded in which puncture was either neglected altogether, or postponed when it ought to have been done early.

As regards pneumothorax due to external injury, what may be called surgical pneumothorax, we must note that the injury may be inflicted by the surgeon himself, as in the following[2] cases.

1. A man, aged 34, admitted to Hospital with peripheral neuritis from drink, during his convalescence became feverish, and showed signs which seemed to indicate a left pleural effusion. The chest was therefore punctured in the sixth space, but no fluid was found. In a few minutes he was seized with dyspnœa, became cyanosed, and was found to

[1] "On Pneumothorax, and the value of its treatment by aspiration." Med. Soc. Trans., xiii., p. 56.

[2] Billroth, "Clinical Surgery" (Syd. Soc. Trans.), p. 192; Ewart, *loc. cit.*

have pneumothorax. He was unable to rest lying down. He continued for some days subject to more or less pain and dyspnœa; but as the displacement of the heart seemed to be less marked than at first, no surgical treatment was adopted. On the sixth day after the accident he died suddenly, in an attack of intense dyspnœa. *Post mortem*, the pleura contained air, and a small quantity of blood-stained fluid. The lung was collapsed, the puncture in it was healed.

2. A man was admitted to Hospital with fracture of the fourth, fifth and sixth right ribs; the skin was strained tight over one of the fragments, and gradually a small patch of skin at this place became gangrenous. On the seventeenth day a sharp point of bone came through the skin, and an attempt was made to remove it with the forceps. At this moment air was heard to pour into the pleura, and pneumothorax was at once evident. It was followed by pleural effusion. The lacerated skin became the starting-point of erysipelas, and of this the patient died twenty-two days after the onset of pneumothorax.

These two cases are of great interest: the first especially is strong evidence of what I have already urged, that one ought not to delay puncture of a severe pneumothorax unless there is some clear reason against it.

So many cases of pneumothorax from injury—contusion of the chest, fracture of the ribs, penetrating wound of the chest—have already been given in the chapters on these subjects that I need not quote more. Its treatment in these cases, if it need to be treated, is on the lines already laid down. It remains for us to consider some general facts as to the character and course of pneumothorax, such as are not outside the range of this book.

An excellent account of it is given by Fräntzel.[1] He refutes the old theories that air can transude through a healthy lung into the pleura, or that pus free in the pleural cavity, as in empyema, can of itself evolve gases

[1] "Ziemssen's Handbuch.," 1875.

to fill the pleura. According to his own experience, phthisis is the cause of it in 14 cases out of 15; and Saussier's figures[1] put the percentage of phthisical patients too low. The phthisis most apt to cause it is rapid in its course, not favourable to the formation of adhesions. In many cases (*e.g.*, in advanced phthisis) pneumothorax may occur without any marked dyspnœa, and the patient may not be conscious of it. But, as a rule, he feels that 'something has given way' in his chest, or may be sensible of the current of air blowing into his pleura; he has pain and shortness of breath, and is cyanosed; and even in the first few days there may be noted œdema of the face and of the extremities. The gravity of the shock and of the dyspnœa may be so severe that the patient dies in a few days, or even hours. It is rare to find only air in the pleura[2]: a secondary pleurisy usually in a few days follows the onset of the pneumothorax: this effusion is of a sero-purulent character, and may be attributed to infection either from the disease of the lung, or from the air in the pleura.

As to the symptoms and physical signs of pneumothorax, pain is not common, save at the onset; cough is variable; and the circulation is obstructed, so that there may be some duskiness of the face, œdema, and scanty albuminous urine. The fulness of the intercostal spaces, and the displacement of the heart, may be even more marked in pneumothorax than in fluid effusions. There is no fever; indeed, the sudden onset of pneumothorax may depress the temperature to 97° or lower; and this is a bad sign, especially if the pulse be very rapid. The pulse is rapid, small, of low tension, the respiration rapid and often

[1] Saussier, in 131 cases, assigns only 81 to phthisis.

[2] Out of 147 cases of pneumothorax, collected by Monneret and Fleury, there were only 16 where there was no fluid effusion.

difficult; but in patients with advanced phthisis the respiratory centres are so enfeebled and ill-nourished that they do not much resent the loss of oxygen. It is the strongest patients, least accustomed to do with only one lung, who are in most danger; and in old phthisical patients one may be led to suspect pneumothorax, not from any complaint on their part, but merely from a change in the pulse, or in the position taken in bed.[1]

To this abstract of Fräntzel's teaching we must add some consideration of the question why so many penetrating wounds of the chest occur without pneumothorax. During the American Civil War,[2] it was the general experience that traumatic pneumothorax very rarely assumed such a phase as to excite alarm. In the vast series of chest-wounds (11,549 gunshot wounds alone, beside incised and punctured wounds) this complication is noted as troublesome in less than half-a-dozen. Indeed, the very opposite may happen, and the naked lung may come out through the wound, forming a hernia of the lung. So far back as 1809, P. J. Roux[3] proved by experiment that a penetrating wound is not necessarily followed by pneumothorax. 'One may see the lung moving freely in respiration, in an animal from

[1] The patient, as a rule, is compelled to sit up in bed, if he is strong enough; or he may prefer to lie on the sound side. Henoch gives a curious case of a man with pyo-pneumothorax, who when his dyspnœa became extreme, would lie on his back, with the upper half of his chest below the level of the lower half, and in this position would rid himself of a stream of pus from the mouth, and so gain relief for a time. *Post mortem*, there was found a wide communication between the pleura and an open bronchus in the upper part of the compressed lung.

[2] "History of the War of the Rebellion," Part i.; Surgical Volume, p. 623.

[3] "On the advantages of pleural adhesions in penetrating wounds of the chest" Mélanges de Chirurgie. Paris, 1809.

whom a great part of the wall of the chest has been removed. . . . . I have often, on dogs, made penetrating wounds on both sides of the chest, larger than the opening of the glottis, and I know that an animal under these conditions lives a long time, and dies only of a sort of gradual asphyxia.' The same lesson is taught both by experiment and by experience.

1. A man, aged 33, stabbed himself in the fifth left intercostal space, inflicting a wound three inches long. At the bottom of it one could see the lung, wounded and still bleeding, but with no sign of collapse. The wound was closed; no pneumothorax occurred, only slight emphysema: and he made a good recovery.

2. A woman, run over by a waggon, suffered fracture of several ribs, emphysema, and hæmoptysis; she died soon after the accident. *Post mortem*, there was found severe laceration of the lung; 'but, in spite of this, the lung was everywhere in apposition with the chest-walls, and there was a complete absence of pneumothorax.' The pleural cavity was free from adhesions.

Now it is not a question of difference between a wound that only opens the pleura without injuring the lung, and a wound that penetrates the lung. Doubtless it is just possible that the pleura should be opened, and yet the lung should escape. But when we consider the immediate apposition of the lung to the pleura, and remember that it is the smallest wounds of the lung that are most likely to cause pneumo-thorax, it is plain that we need hardly think of those most rare cases where the injury opens the pleura, but stops short of the lung.

Let us first notice some arguments that help to explain the matter.

1. We do not yet, in spite of all that has been observed in practice or proved by experiment, fully understand the exact causes of collapse of the lung. Experiments are still being made to settle the question,

but at present we must admit that it does not seem to follow the invariable laws of a purely physical process.

2. 'It is not improbable that the state of the patient's strength exerts considerable influence upon the production of collapse of the lung, the accident being more likely to take place when he is exhausted by shock and loss of blood, than when he is able to command the free use of his respiratory muscles. In the latter case, his efforts, which are often very violent, enable him effectually to resist the encroachment of the air, and even to force the lungs somewhat out of the chest.'[1]

3. In the case of gunshot wounds, the substance of the lung is rather bruised than clean cut. This bruising would tend to block the air-vesicles and smaller bronchial tubes.

4. Adhesions do most certainly play a very important part in preventing pneumothorax after a penetrating wound of any kind. We know how common these are in the *post mortem* examination of cases where during life there was no reason to suspect their presence; and it may be noted that the great majority of knife and bullet wounds in Hospital practice are inflicted on those whom poverty has exposed all their life to every circumstance most likely to favour the formation of adhesions. In the army, also, Billroth has especially recorded the great frequency of adhesions in the older men in the French army. There is an interesting old essay on this subject by P. J. Roux, 1809, but unfortunately he does not quote any cases. The following[2] are of interest here :—

1. A man, aged 20, was stabbed in the back, between the

[1] Gross, "System of Surgery," ii., p. 368.

[2] Billroth, "Clinical Surgery" (Syd. Soc. Transl.) 1881, p. 190; Erichsen's "Surgery," 8th ed., i., p. 832; Nélaton's "Lectures on Surgery," edited by Atlee, 1855, p. 55.

left scapula and the spine. There was a moderate amount of hæmorrhage; no dyspnœa; no pneumothorax. The wound was closed with strapping; three days after the injury, the wound was probed; thereupon severe pleurisy occurred, which lasted three days. 'From the symptoms in this case, it seems possible that the wound had perforated an adhesion.'

2. 'I had once under my care a woman who had extensive emphysema of the areolar tissue of the trunk from fractured ribs, but without any pneumothorax, the lung having been wounded at a spot where it was attached to the walls of the chest by old adhesions, and the air having passed through them into the areolar tissue of the body, without first entering the cavity of the pleura.'

3. A young man stabbed himself in the fourth left intercostal space, about two inches from the sternum. He fainted, and on recovering consciousness, suffered severe dyspnœa. Next day, there was emphysema up to the clavicle; great oppression; and a limited pneumothorax at the wound and over the heart, and for about an inch below it. 'How was it, however, that respiration could be heard all over the chest behind, and over the upper half of it in front? On asking the patient, it was found that he had been very subject to pectoral affections, and it was supposed that in consequence the lung had become united by false membranes to the walls of the chest.'

Still, these considerations do not carry us far. The real reason why pneumothorax is so rare in penetrating wounds of the chest is given in Dr. West's most valuable Bradshawe Lecture. Among many physical experiments that he made, the following must be noted: (1) Two discs of wood, perforated in the centres, were covered with pieces of stomach, drawn tight over them, with the peritoneal surface outward. When pressed together, the discs could not be drawn apart, even after one of the membranes had been incised, by the exercise of a force equal to the normal elastic recoil of the lung: (2) Over the mouth of a bell-jar, fitted at its closed end with an air-pump, were stretched two pieces of stomach, with their peritoneal surfaces in apposition. The jar was ex-

hausted of air till the negative pressure within it became equal to the force exercised by the normal elasticity of the lung: then a slit was made in the outer of the two membranes. They still remained in close apposition. 'There is some force, other than atmospheric pressure, by which these two smooth surfaces were held together; and without using the term in too technical a sense, I may speak of it as cohesion. . . . . Pneumothorax, therefore, is a condition brought about by the forcible separation of the pleural surfaces, and in this respect exactly analogous to the distension of the subcutaneous tissue which obtains in surgical emphysema. So far from being, as it is commonly regarded, a passive process, and inspiratory in origin, it is really expiratory in its origin, and requires an active force to produce it.'[1]

We have now gone over the chief causes and symptoms of pneumothorax, and the chief points of treatment. We must further remember that in cases of injury we may have blood, as well as air, effused into the pleura, giving rise to a different set of physical signs. The diagnosis is in most cases not difficult; but Fräntzel records that he has twice mistaken a large tubercular cavity for pneumothorax. The same mistake is also not unlikely to be made in some cases of subphrenic abscess containing air. The onset of pneumothorax is in some instances so sudden and so alarming, and the questions relating to it are of such interest, that it must command our best consideration; but it is not often so acute or so serious as in

[1] It is probable that this cohesion is not equally powerful over the whole surface of the lung: that is to say, the more movable part of the lung, near its edge, would slip away and allow air to enter the pleura. See Mr. A. H. Smith's experiments, given in the "History of the American War," Part i., surgical volume, page 631: and, above all, Mr. Godlee's paper in the "Practitioner" a few years ago.

some of the cases here quoted. We are bound, however, to be familiar with it, and to be ready to treat it without delay, if it is severe. And the best treatment, if the symptoms do not abate under the use of opium, is probably simple puncture—not aspiration, lest we should re-open the small perforation in the lung. In certain cases puncture may not suffice, and the surgeon may find it necessary to make a free incision, with or without resection of a rib.

CHAPTER VII.

HERNIA OF THE LUNG.

THE signs and symptoms of hernia of the lung are so remarkable, and its course and treatment afford such pleasant subjects for speculation, that we are in danger of forgetting how rare it is, and how simple its treatment ought to be. Out of more than twenty thousand wounds of the chest in the American war, there were only seven cases of hernia of the lung. In the Crimean war, not a single case was reported in our army. Samuel Cooper saw one at the battle of Waterloo, and Guthrie saw three at Brussels after the battle. Mr. Erichsen records one only, which he saw in Velpeau's wards in 1839.[1] For the study of the whole subject we have, happily for us, Morel-Lavallée's admirable essay and collection of 32 cases, and from him and other writers we are able to understand the absorbing interest that hernia of the lung has always had for surgeons.

We are not now concerned with those cases in which the lung is exposed through some congenital gap in the ribs, or with those one or two recorded cases where the apices of the lungs have been situated so high as to form a sort of hernia above the clavicles: but only with cases of hernia of the lung due to injury. Among the possible injuries that may cause it, we must reckon

[1] For some recent cases, see Mr. Pitts' Lectures, "Lancet," Oct. 14, 1893; and the "Transactions of the Ninth Congress of the French Surgical Association," Paris, 1895. A case is given in Reclus' paper (see Appendix), and Tuffier has operated successfully for the "radical cure" of chronic hernia of the lung.

coughing or straining. Mr. Erichsen has noted a case in a man who earned his living by playing the cornet:[1] Boerhave saw it occur after child-birth in a primipara. Chaussier[2] gives a case of hernia of each lung, with displacement of the costal cartilages. Each hernia had occurred after a severe cough, one a considerable time before the other, but both in the course of the same year. On the left side, between the eighth and ninth ribs, there was a large hernia, passing through a ring more than two inches in diameter. The cartilage of the ninth rib was separated from the bone; there was undue mobility, and slight crepitation. On the right side was a smaller hernia, between the seventh and eighth ribs. The patient had no trouble from them; he wore an abdominal belt, and held his hands over them when he coughed. Probably in this case the costal cartilages had been broken by muscular action during fits of coughing, thus allowing hernia to occur. After simple fracture, it may not begin to appear for many weeks, or even a much longer time, after the accident.

A man, aged 65, fell out of a cart, and broke the sixth and seventh ribs of the right side, about the junction of their posterior and middle thirds. Within a fortnight of the accident he removed his bandages, at the bidding of a quack doctor; he now suffered severe pain, and soon he noticed a swelling, which was at first no bigger than a hazel-nut, but rapidly grew larger. At first, it only appeared when he coughed; then it was always present. Three months after the accident it was as large as one's fist, and had not gone back for a fortnight. It was soft, even, elastic, passive, easily reducible; the skin over it was natural; it moved with the movements of respiration, swelling in inspiration, falling in expiration, becoming distended during a cough, then slowly subsiding. It

[1] Escape of air into the cellular tissue of the body has also been observed under these conditions; see chapter on Emphysema.

[2] "Bull. de la Faculté de Méd.," Paris, 1814, iv., 50; quoted by Gurlt.

was not painful, but gave him a feeling of trouble, oppression, dragging inside the chest, and shortness of breath, so that he would pant for breath after a cough. He wore a pad and bandage night and day for two years, then only by day, and thus was cured.

Hernia of the lung from direct penetrating wound of the chest occurs at once, or at the latest within twenty-four hours. Still, it is not impossible that a small wound may scar over, and yet hernia may afterward occur beneath the scar.

A man, aged 29, in a duel, was wounded with a rapier just below and to the inner side of the left nipple. 'How deep was the wound? One could hardly tell; but he had no severe pain, no palpitation of the heart, no severe shock; there was no hæmoptysis, no great dyspnœa, nothing to indicate hæmorrhage into the pleural cavity; very little bleeding from the wound.' By the fourth day all bleeding had ceased, but he complained of sharp pain referred to the left shoulder, and had a short hacking cough. A week after the injury the wound was healed, but he still had a cough, and was short of breath. Six weeks after the injury, he first noted a swelling under the scar, and was found to have hernia of the lung.

Setting aside these very rare cases of secondary hernia, we come to the common form of hernia, where the lung protrudes, at once or in a few hours, through a wound of the chest wall.

1. A child, aged 13, fell from a height, coming down on a sharp piece of wood, and suffered extensive laceration of the fifth right intercostal space near the sternum. The surgeon, called at once, found free bleeding from the interior of the chest, and a large hernia of the lower lobe of the lung. The condition of the patient appeared hopeless; intense oppression and distress, frightful pallor, a feeble pulse, cold hands and feet. There was no hæmoptysis. The protruding portion of lung was with some difficulty reduced, and the wound was closed. The child remained in a state of shock for three days; then came excessive reaction, which was treated by venesections. Complete recovery. (Angelo, 1844.)

2. A man, while drunk, received a penetrating wound below the left nipple, but was too drunk to heed it, or to call

for help. The next day he found a protruding portion of the lung, of three fingers' breadth. He now took a two days' journey to Amsterdam, with the lung still hanging out, unheeded and undressed.[1] Tulpius ligatured it, and cut it off with scissors: it weighed three ounces—"poids énorme pour un viscère si rare et si léger." The patient healed quickly, and had no further trouble, save a cough at times. (Tulpius, 1674.)

3. A young soldier in the American war was shot in the left side of the chest, a little below the nipple. 'Our attention was called to him the night after the battle. He was lying upon the ground in a condition of considerable prostration. The hernia was about one inch in diameter, having escaped from an aperture which was very much smaller. It was completely strangulated, being quite black, and insensible to the touch. We applied to the neck of the hernia a strong silk ligature. . . . We saw him the next morning lying in the same place; he had lain without shelter two nights, each night in a drenching rain; in this respect he suffered, however, only in common with at least two thousand other wounded and dying men.' The boy was moved into Hospital. The issue of the case is not known.

From these cases, which are none the worse for being old, we may draw a good clinical picture of hernia of the lung after injury. It will be observed that the wound is, as a rule, of some considerable size. Poland, in saying that it is usually a small wound, is opposed to the general opinion on this point. The symptoms that we should expect to attend the sudden displacement of the lung are not very definite, and are mostly lost in those of the original injury. The front and sides of the chest, especially the lower intercostal spaces, are the most common sites of hernia; and it is usually the thin mobile edge of the lung that is concerned in it. There is evidence, both experimental and clinical, to show that even though the lung itself be wounded, the

[1] "Die Lungen ein ungemein tolerantes Organ sind." Riedinger. "Le poumon est pour le traumatisme chirurgical ou opératoire un organe extrêmement tolérant." Michaux.

wounded part may yet be protruded. Extensive pneumothorax, or old adhesions at the seat of injury, would of course render hernia impossible.

How is it affected by inspiration and expiration? It is certain that more than one case has been reported where the surgeon had no doubt that the hernia increased on inspiration, and sank on expiration. Against these re-reports, Morel-Lavallée, and Otis, in the History of the American War, declare most emphatically that those who published them must simply have been mistaken. 'We must believe that these statements of the augmentation of the tumour being synchronous with inspiration, were all founded on faults of memory or errors of observation.' And certainly it is hard to see how any act of inspiration could overcome the pressure of the atmosphere. But I suppose it is possible that, in a secondary hernia, the condition of the herniated portion, and its relations to the adherent tissues round it may be so altered that this portion may not behave like the rest of the lung.

Slow natural expiration, so far as we know, would not cause increase of the hernial swelling. But sudden, violent expiration, and especially coughing or straining, are what cause and aggravate it. Like emphysema and pneumothorax, it is an expiratory process. Though in ordinary expiration the lung retreats or is, as it were, pushed back as the chest contracts, we have in violent and sudden expiration a very different state of things. The glottis is closed or nearly closed; the air in the lungs is suddenly put under increased pressure. A sudden knife or gunshot wound of the chest is followed by an immediate forced expiration with closed or half-closed glottis, raising the pressure in both lungs, or causing overflow of air from the sound into the injured lung, and thus the hernia is brought about. Without cough or violent expiration, it could not occur.

A hernia that has come gradually, not at once, may possess a true sac, lined with pleura. It may be wholly free from adhesions, and reducible; but the lung does not fly back, or empty itself on pressure, like a hernia of the bowels.

Cases are recorded where hernia of omentum has been mistaken for hernia of the lung, and *vice versâ*. Chronic abscess of the chest wall has also been mistaken for it. And the difficulties of diagnosis will be great indeed if the diaphragm has been torn, so that the bowels, ascending into the thorax, simulate a hernia of the lung, or are added to it, as in the following cases:—

1. A man, aged 33, was crushed under a gun-carriage. His condition at first seemed hopeless. Blood poured from his mouth and nose; he was collapsed, and had frequent attacks of syncope; but he survived, and partly recovered, and for the next seven years just dragged about from one Hospital to another. In the eighth left intercostal space, at the junction of ribs and cartilages, was a small tense tender irreducible swelling, about an inch across. 'On any exertion it increases in size; at times it becomes as large as a hen's egg, and is then very hard, and exquisitely tender, and moreover causes all the symptoms of a strangulated hernia—hiccough, nausea, vomiting, abdominal pains, retraction of the abdominal wall—and he lies on the affected side, pressing his hands to his abdomen.' He was unable to bear the pressure of a bandage, and left the Hospital. (Cloquet, 1819.)

2. A soldier received a gunshot wound in the eighth left intercostal space, fracturing the ninth rib; there was no sign that the lung was wounded; he walked a mile and a half to the rear, and entered a field Hospital. There was a protrusion of the lung of the size of a small orange; it could not be reduced, even after enlarging the wound. Next day, after further vain attempts at reduction, it was ligatured, and sloughed, leaving healthy granulations. It slowly healed, but there remained a troublesome hernia under the scar, preventing him from further active service. Three and a half years after the injury the swelling became suddenly enlarged, as he was straining to lift a heavy weight. A note of the case two months later says, 'It now measures five inches by four and a half. There

is often nausea after eating, and great pain. Pressure over the swelling causes a gurgling sound in it, and sounds of movement of the bowels. Traction on it causes nausea. A portion of the stomach has undoubtedly escaped through the diaphragm, and through the opening in the thoracic walls.' Five years later he was in better health, and the swelling was rather smaller, and less troublesome. (Amer. War, 1863.)

But as a rule, the nature of the protrusion is evident; its history, its movements in respiration, the feel of it, the fine vesicular murmur or crackling sounds on auscultation, the resonance on percussion—all guide us to a right diagnosis.

As regards prognosis, it is to be noted that after the first occurrence of the hernia there is no fear that it will at any later period become strangulated. Even in traumatic hernia the prognosis is fairly good. 'In eight cases of this kind—though in every one of them, according to the surgeon who observed it, the lung was lacerated, bloodless, or gangrenous—and, let me add, though the treatment was irrational, only one patient died, and the rest did not show a single sign of serious trouble.'[1]

It is necessary to remember that a piece of lung thus exposed and constricted very quickly becomes hard, dry, and dark, and yet may not be strangulated past recovery. 'They have made this mistake, almost all of them,' says Morel-Lavallée, 'and that is why, in almost every case, they have cut away the lung, instead of reducing it.' Boyer[2] says the same. 'One might easily mistake the dry dusky look of the exposed lung for strangulation, and therefore cut off a portion which one ought to save. Loyseau had a case where a man received an extensive sword-wound in the third right intercostal space. A portion of lung escaped, became swollen, and remained

[1] Morel-Lavallée.

[2] "Traité des Maladies Chirurgicales," 1824, vii., p. 266.

for three or four days unreduced. It became shrunken and dry, was considered gangrenous, and was cut off level with the skin. But when one put the piece removed into water, it regained its natural colour, as doubtless it would have done if one had reduced it.'

Perhaps we cannot trust this last sentence; but it is certain that a hernia may appear badly strangulated, when it will yet recover if put back inside the chest. But is reduction so easy? There are, at most, only a few recorded cases where it was found possible. Steady pressure, while an assistant with blunt hooks retracts the ribs, and the patient slowly draws a deep breath, may be successful; or it may be necessary slightly to enlarge the wound. Should these measures fail, it is hard to see what is gained by the ligature. Poland mentions two cases, where the exposed lung, left to itself, gradually receded till it became level with the skin, and so healed. Guthrie says of the three cases that he saw at Brussels, after Waterloo, 'They were not interfered with, greatly to the advantage of the patients.' The surgeon therefore had best be content with keeping the exposed lung in such dressings as may ensure its vitality and safety from infection.[1]

That one page at least of this book may be beyond the blame of being dull, I transcribe a case four hundred years old. 'Called to a citizen of Bologna on the sixth day after his wound, I found a portion of the lung issued between two ribs; the afflux of the spirits and humours had determined such a swelling of the part, that it was not possible to reduce it. The compression exercised by the ribs retained its nutriment from it, and it was so

[1] Couvy collected 14 cases treated by removal of the protrusion, with 12 recoveries. Heydweiller advises removal, as more reasonable and more sure of success than non-interference.

mortified that worms had been developed in it. They had brought together the most skilful chirurgeons of Bologna, who, judging the death of the patient to be inevitable, had abandoned him. But I, yielding to his prayers, and to those of his parents and his friends, and having obtained the leave of the Bishop, the master, and the man himself, I yielded to the solicitations of about thirty of my pupils, and made an incision through the skin, the breadth of my little finger-nail away from the wound, all round it. Then, with a cutting instrument, I removed all the portion of the lung level with my incision. The wound resulting from this resection was closed by the blood issuing from my incision, and was dressed frequently with the red powder and other adjuvants. By the grace of God it cicatrised, and recovery took place. It is true that one had to wait long for it. The patient, with his master Rolandini, has since then made the voyage to Jerusalem, and has returned in good health.

'If you ask me what I should have done in this case, if I had been called to it at once, I answer that I should have dilated the wound with a small piece of wood, keeping the lung warm with a cock or a fowl split down the back, and should then have reduced it, and kept the wound open till the portion of lung was wholly mortified. If you still question me, to know how this man can live without his lung, I answer that the part remaining within the chest profits by the nutriment destined for the whole of the lung, and so is developed, and that nature has been able to create supplementary parts in it, which is an easy thing in an organ that is soft and near the warmth of the heart.'

Rolandus published this case in 1499.

CHAPTER VIII.

WOUNDS OF THE INTERCOSTAL AND INTERNAL MAMMARY ARTERIES. HÆMOTHORAX.

We now approach one of the greatest and most vital subjects in surgery—the course and treatment of penetrating wounds of the chest. We must not in any way neglect the usual division into penetrating and non-penetrating wounds; but on the other hand we must not make too much of it. We may be quite unable to say whether a wound has or has not penetrated the chest; and we may make a mistake in such a case if we do too much to satisfy ourselves on this point. And this division, again, by no means indicates the extent or gravity of the injury. 'An innocuous puncture with a capillary trochar is a penetrating wound, and rupture of the heart or laceration of the lungs without external wound is a non-penetrating wound.' As in wounds of the head or abdomen, so here, our chief thought is for the contents of the cavity, not for the cavity itself.

We have already given attention to emphysema and pneumothorax. The third, most common, and most dangerous result of wounds of the chest remains for our consideration—hæmorrhage, either through the wound, or running unseen into the pleural cavity, or coughed up through the mouth, or all three altogether.

But, before we come to wounds of the lung, there is a set of cases standing on the border-line of the old division between penetrating and non-penetrating wounds—cases of wound of the intercostal or internal mammary vessels.

Happily, they are seldom wounded. When they are, the injury is often fatal, and often not recognized by the surgeon. With the wounds of these vessels we may also consider in this chapter the course and treatment of hæmothorax: thus clearing the way for a general consideration of wounds of the lung.

Wounds of the Intercostal Arteries.

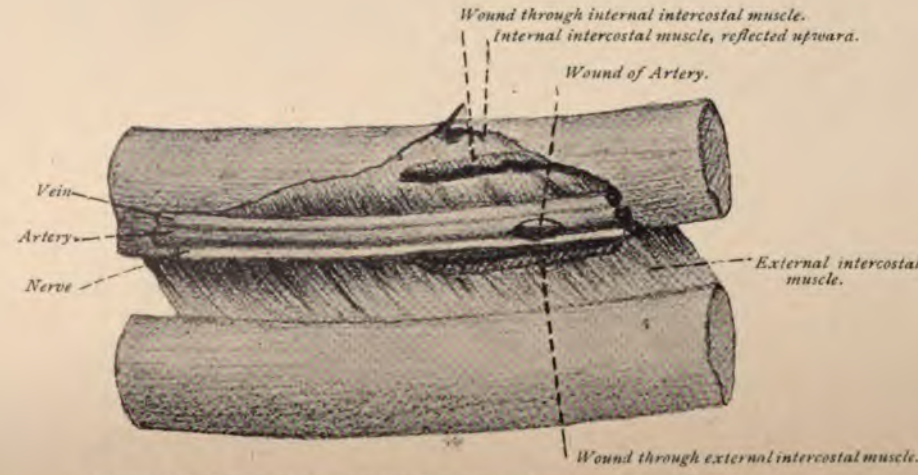
In the study of the surgery of this or that region or organ of the body, one naturally is most interested in the record of any case where the surgeon himself has inflicted the injury. I put first, therefore, two instances[1] where an intercostal artery was wounded in the operation for empyema.

1. A young man was admitted to Hospital with empyema of the left side, consequent on a penetrating gunshot wound of the chest. The empyema communicated with an abscess of the chest-wall which had already been incised. The surgeon, to enlarge the opening into the chest so that he might wash out the empyema, made an incision into one of the intercostal spaces. This was followed by hæmorrhage; the patient became collapsed and unconscious, and died. *Post mortem*, a small incision, ⅜ inch long, was found in the intercostal artery.

2. A man, aged 45, was admitted to Hospital suffering with empyema of the left side, gangrene of the lung, and pneumothorax. Aspiration had given very transient relief, and his condition was almost hopeless. A free incision was made in the seventh intercostal space, and more than a quart of fœtid blood-stained pus escaped under great pressure. Four or five minutes later he became very pale, was bathed in sweat, and the dressings were soaked with blood. They were removed, and blood was found bubbling over the lower edge of the wound, but in no great quantity. The finger, passed into the wound, felt a hot jet of blood directed against it. The hæmorrhage was stayed with a plug

[1] Dulac: "De la Blessure des Artères Intercostales dans les Plaies de Poitrine, et particulièrement dans la Paracentèse," Thèse de Paris, 1874.

PLATE II.



Wound of the Intercostal Artery in the Operation for Empyema. (From Dulac.)

pressed up into the groove for the intercostal vessels and nerve; but the patient died almost at once. *Post mortem*, a wound $\frac{3}{4}$ inch in length was found in the intercostal artery. The specimen from this case is shown in *Plate II.*

Happily, this 'calamity of surgery' must be very rare I can find no further record of it. Fräntzel[1] says: 'I have never seen the main trunk of an intercostal artery wounded in incision of the chest; one can always avoid it. But I have twice wounded a branch of it; and in one case, where the artery lay deep beneath a thick covering of muscles, I had considerable hæmorrhage, which it was difficult to stop. It is hardly possible to tie the bleeding point; one must therefore have resort to compression, taking care that blood does not still pass, unnoted, behind the plug into the pleural cavity.'

By numerous experiments on the dead body, Dulac found that an intercostal artery can be easily wounded by an incision close to the lower border of the upper rib, either in the sixth, seventh, or eighth space, alike in the anterior, lateral, or posterior part of the chest.

The following cases[2] clearly illustrate the usual cause and course of wounds of the intercostal arteries.

1. A wood-cutter wounded himself in the left side of the chest with a bill-hook. 'Called to him a few minutes after the accident, I found him lying on his back, with an irregular transverse wound below the left nipple; a little blood flowed from it. From the direction and size of the wound, and the shape and length of the bill-hook, I was of opinion that the wound had penetrated the chest. His breathing was easy; neither the colour of the blood, nor any issue of air from the wound, pointed to injury of the lung. I bled him freely at once, and applied a compress and a bandage. Two hours later I saw him again; he was lying on the wounded side,

[1] Ziemssen's Handbuch, *loc. cit.*, 1875.

[2] For references, see Dulac, *loc. cit.*: History of the War of the Rebellion. The first two cases are many years old, but they are none the less worthy of consideration.

his face blanched, his pulse small and rapid, his breathing difficult and oppressed: and there was dulness over the wounded side of the chest. There was thus no doubt that he had blood in the left pleura. But what was the source of the hæmorrhage? There was no sign of any wound of the lung. The sharp concave edge of the bill-hook had been turned outward; the blunt edge had been toward the lung. It therefore seemed probable that an intercostal artery had been wounded, and I advised that the wound should be re-opened, and the artery compressed. This advice was opposed, and he was again bled from the arm; his breathing became worse, violent convulsions set in, and he died in half-an-hour. *Post mortem*, the left pleura was full of blood; the diaphragm was pushed downward; the lung was pushed backward and upward, slightly bruised at one point, but not wounded. The wound had laid open the sixth intercostal space, and had cut the lower edge of the fifth rib, the nerve, and the artery.'

2. A man, aged 34, bent on suicide, stabbed himself in the third left intercostal space, 'about an inch deep.' He withdrew the knife, and fell. 'There was at once a severe hæmorrhage, with all the signs of a penetrating wound with injury of the lung.' (It is not said that there was any hæmoptysis). He was admitted to Hospital, the wound was dressed and bandaged; throughout the night he suffered severe oppression, and frequently fainted. 'Next morning, we found the dressings and the bed soaked with blood; his face was pale, his lips colourless, his eyes dull and glazed; bright blood trickled from the wound; its edges were swollen, crepitant, and here and there fluctuant; his extremities were cold, pulse small, breathing difficult and laboured. Plainly he was bleeding either from the lung, or from an intercostal artery; and I suspected the latter. I enlarged the wound, turned out a quantity of clots, and examined it with my finger; cleaned it well, and found bright blood issuing from between the intercostal muscles where his knife had cut them. I divided some of the muscular fibres, and with a fine curved needle succeeded in tying the artery at once.' The effusion of blood into the pleura was followed by empyema. The patient finally recovered.

3. A young soldier, aged 17, received a penetrating gunshot wound of the chest, fracturing the ninth left rib, three inches from the spine, and wounding the lung. For three weeks he did well: the lung seemed healed, and the wound was healing. On the twenty-third day severe secondary

hæmorrhage came from the wound; the bed was soaked with blood, and the patient was almost unconscious. 'I slightly enlarged the wound and removed some fragments of bone. Meanwhile the arterial jet was becoming stronger, and the patient momentarily weaker; there was evidently no time to be lost.' Digital pressure was kept up; chloroform was given, and with a blunt curved needle on a handle the whole rib was ligatured on either side of the fracture. The bleeding stopped at once, but the patient sank and died two hours later. *Post mortem*, it was found that the ligatures had been passed round the rib successfully without lacerating the pleura.

4. A soldier, aged 26, received a gunshot wound of the chest, fracturing the eighth and ninth ribs, but not wounding the lung. He suffered from rigors, with profuse sweating; and on the ninth day, considerable secondary hæmorrhage came from the wound. The wounds of entrance and of exit were laid open into one incision, the fractured ends of the ribs were cut off with the bone-forceps, and the intercostal artery was picked up and ligatured. 'The pleural cavity did not seem to have been opened by the ball. But the motion of the cut end of the rib wore an opening, and also divided the artery, and hæmorrhage again occurred; two days after the operation the vessel was again tied, and the rib cut off still further.' The patient died of exhaustion about a month after the injury.

5. A soldier received a penetrating gunshot wound of the chest; the ball, passing out, fractured the tenth right rib and the lower angle of the scapula. A fortnight later, secondary hæmorrhage occurred several times during the night, and in the morning the skin was found swollen with blood, and the patient was blanched and very feeble. Under an anæsthetic the wound was enlarged, spicules of bone were removed, a quantity of clot was turned out, and the artery was ligatured. No further bleeding occurred, and for a time he did well; but he died of empyema about a month later. *Post mortem*, the lung had been wounded, and was adherent; there was dark unhealthy pus in the pleura; the fractured ends of the rib were necrosed.

6. A young soldier, aged 18, received a gunshot wound of the chest, the ball entering the fifth left intercostal space, and lodging in the lung. On the eighth and again on the ninth day, secondary hæmorrhage occurred from the intercostal artery. An attempt was made to ligature the vessel, but from the narrowness of the intercostal space, and the

depth of the wound, it was found impracticable. He died the same day. *Post mortem*, a quantity of blood was found in the pleura. He had lost nearly a pint of blood on the occasion of the last secondary hæmorrhage.

But these cases give a one-sided view of the treatment of a wounded intercostal artery. In the American war, out of a total of 15 cases, variously treated, 11 ended in death. In 8, an operation was performed; of these, 6 died: one from pyæmia, one from empyema, one from exhaustion, and three from secondary hæmorrhage. 'The operations had scarcely more successful results than the cases treated by compression.' Are we then justified in believing that it is not necessary to operate in these cases, or to do more than plug the wound?[1]

In any case of *secondary* hæmorrhage from an intercostal artery, the surgeon ought to operate at once, and will probably have to resect a piece of rib.[2] He must remember that the bleeding is most serious, and the artery most difficult of access, in the posterior part of the chest. In any case of primary hæmorrhage, he will probably have immediate recourse to digital compression of the wound, followed by plugging with a well-fitted compress: not because he thinks compression is in itself better than ligature, or so good, but because of the enfeebled state of the patient, or because there is reason to think that the bleeding is from the lung. But such a case must be

[1] The best method of compression is that given by Desault. A square piece of lint is pressed into the wound, then its four corners are brought together so that it forms a pocket, and this is tightly packed with lint so that the whole wound is well compressed.

[2] Innumerable methods were devised by the older surgeons—trephining the rib; drilling it; introducing discs of metal; using various ways of passing a ligature—"some dangerous, others trivial, and others more ingenious than useful."

watched from hour to hour, and he must be prepared to interfere at any moment, to open the wound freely, and to expose the artery, or even the lung itself.

An isolated wound of the artery, without wound of the lung, is, of course, very rare. One may suspect it if the wound be of such a depth and direction as to cause it; if there be external hæmorrhage, or hæmothorax, or both, without hæmoptysis or pneumothorax; if the external hæmorrhage be arterial in colour, but unmixed with air; and if the finger, introduced into the wound, feel a jet of blood spurting on it. It is useless to try the old method of laying a thin edge of something, such as a card, in the wound, to see if the blood flows from above it or from beneath it; one's finger is alone likely to be useful. Riedinger[1] puts the subject very clearly. Having enumerated all the complicated devices of the older surgeons, he says, 'It is really wonderful, at the present time, how so many great surgeons were possessed with the idea that an intercostal artery could not be secured without all these contrivances. If you can't stop the bleeding by plugging the wound, you must enlarge the wound and tie the vessel. If you have difficulty in getting at it, *e.g.*, if it has been wounded far back in the chest, you must resect a piece of rib; or, better still, loose the periosteum off the rib, and thus reach the vessel.'

Finally, it is to be noted that aneurysm of the vessel has been observed, in at least one case, after wound of it.

Wounds of the Internal Mammary Arteries.

We have here to consider another rare injury, seldom occurring by itself, difficult of diagnosis, very difficult of

[1] Riedinger, *loc. cit.* p. 110.

treatment, and usually fatal. The depth of the vessel, especially in the lower part of its course, and its position behind a barricade of costal cartilages, in the loose tissue of the mediastinum, close to the pleura and the pericardium, make diagnosis and treatment matters of almost insuperable difficulty. The mediastinal tissues, the cavities of the pleuræ, and of the pericardium, may one or all of them be the seat of internal hæmorrhage; the soft tissues may be swollen with blood; and they, and the costal cartilages, may be so bruised or shattered, as in a case of gunshot wound, that the surgeon may have nothing to guide him to the artery, and cannot be sure that it is the source of the hæmorrhage.

We must remember that any incised or gunshot wound near the border of the sternum must be very carefully watched; that a divided costal cartilage may close over the cut artery, and direct the hæmorrhage inward; and that ligature of the artery is fairly easy in the second and third spaces, difficult in the fourth, very difficult in the fifth, and almost impracticable in the sixth. 'The operation is not difficult in the upper intercostal spaces, except in those cases of gunshot fracture in which the relations of the parts are disturbed. When there is an open wound, when the adjacent soft tissues are swollen and infiltrated, and the vessel lacerated and displaced, the operation becomes very difficult: then it is best to have recourse to compression.'

In the literature on this subject, there are two treatises of especial value. One is on the 'History of the American War,' from which I have just quoted. In the records of the war, there are only five or six cases in which wounds of the internal mammary were distinctly recognized. Three of these were treated by compression and styptics, and two by ligation. 'But there are many other re-

corded instances of wounds near the edge of the sternum, with hæmorrhage yet without hæmoptysis, in some of which the existence of this lesion may fairly be suspected.' It was fatal in all the five cases in which it was clearly recognized. In three cases of gunshot wound, with severe laceration of the tissues, the hæmorrhage was secondary; in one on the 14th, one on the 37th, and one on the 53rd day after the injury.

Our other guide to the study of this subject is the admirable essay by Tourdes.[1] And as I cannot hope to make or quote any clearer rules for diagnosis or treatment than those which each of us may make for himself by reading Tourdes' collected cases, I give them in full.

1. A child, falling on broken glass, cut its seventh costal cartilage, and divided the external branch of the artery. The pleura was not opened. Ligature was tried, but found impossible. A compress was applied. Recovery, after exfoliation of cartilage.

2. A soldier received a sabre-wound, which divided the seventh right costal cartilage, severed the artery, and opened the pleura and the pericardium, but did not injure the lung. Only a compress was used. He suffered agonies of distress and an overwhelming sense of oppression, as from hæmorrhage into the pleura and pericardium. Finally, the extravasation into the pleura was absorbed, and he recovered.

3. A soldier, aged 30, received a bayonet wound, a mere puncture, just below the second right costal cartilage, close to the sternum. Only a few drops of blood escaped, and there was no hæmoptysis. He at once suffered a frightful sense of oppression, and was bled thrice in forty-eight hours. Then signs were found of hæmorrhage into the right pleura; and on the sixth day he suffered intense dyspnœa, and seemed at the point of death. An incision was made into the pleura, and 2 pints of blood and serum were let out, to his great relief. He slowly recovered.

4. A man was shot, the bullet fracturing the fourth

[1] "Annales d' Hygiène Publique," Paris, 1849, xlii., p. 165.

left costal cartilage close to the sternum, and lodging in his back, whence it was removed. He was bled repeatedly. On the third day there was severe hæmorrhage from the artery, or from a branch of it; and so much blood was poured into the pleura that on the fifth day he was near dying of suffocation. He was put face downward, and a pint of broken-down blood flowed from his wound; and this primitive method was repeated for many days. On the eighteenth day the pleura was incised, and a pint of fœtid blood was let out. The incision was kept open, and sixteen weeks after he was shot a bit of his shirt was removed through it. A month later he was healed.

5. A man, aged 40, was stabbed between the third and fourth right costal cartilages, and the latter was divided. The wound bled freely; he had hæmoptysis, with intense dyspnœa and prostration. The external hæmorrhage ceased of itself. Some days later there were signs of fluid in the right pleura; on paracentesis, 4½ pints of fœtid blood were withdrawn. He slowly recovered.

6. A man was shot, the ball fracturing the third and fourth left ribs, lacerating the artery, opening the pleura, and just grazing the lung. He died in forty-eight hours, and 3½ pints of blood were found in the pleural cavity.

7. A duellist received a sword-wound, which entered between the first and second left ribs, close to the sternum, and wounded the artery, the lung, and the intercostal artery near its origin, and passed out between the second and third ribs behind. The hæmorrhage was frightful. The wounds were at once adjusted and closed. Up to the eighth day he improved; then a change for the worse set in, with high fever. An incision into the pleura let out several pints of broken-down blood. Five weeks after the injury, his wounds front and back were healed; the discharge from the pleural cavity was less; the chest-wall was falling in. Nine weeks later he gave himself up to excesses of every kind; lost ground slowly, and died in five weeks, or 134 days after injury. *Post mortem*, pleural cavity reduced by one-third; pleura and pericardium much diseased; sword-wounds healed; divided ends of the artery retracted and obliterated.

8. A man, bent on suicide, stabbed himself, cutting the fifth left costal cartilage close to the sternum; bright blood spurted from between the cut edges of the cartilage; he was much collapsed, and there were signs that the lung and the pericardium were involved. The wound was closed at once,

and for eight days he was now better, now worse. Then came intense pain at the wound, and he could not lie on that side: but no signs of pleural effusion were found. To his pain and distress were added wasting and diarrhœa; and as the days went on, it was noted that the heart-impulse felt faint and remote, and seemed to be transmitted through fluid. On the forty-eighth day, therefore, believing that he had to deal with a large hæmorrhage into the pericardium, Larrey cut down through the fifth left space, just below the nipple. He let out serous fluid, mixed with blood-clot; it escaped in jets, in time with the heart, and he thought that his finger touched the apex of the heart itself. The incision suppurated for eight days, and then closed; then the patient's troubles returned, and it was re-opened. He did well for some time, but died exhausted with vomiting, diarrhœa, and wasting, on the sixty-third day. *Post mortem*, no fluid in the pleura; lung adherent. Occupying the whole of the anterior mediastinum, and extending back toward the spine, was a large shut-off cavity, its walls lined with dark purulent fibrinous deposit; it was this encysted hæmorrhage that had been taken during life for the cavity of the pericardium. The pericardium was adherent; a thin clot lay over the right ventricle; there were faint traces of a scar of the pericardium and of the heart. The artery was completely divided.

9. A man, aged 26, received a sabre-wound between the second and third right costal cartilages, near the sternum; bright blood poured from the wound, and he also coughed up blood. The wound was closed; he was bled; and on the sixth day the hæmoptysis had ceased, the wound was healing, and he was doing well. On the eleventh day there was increased distress, high fever, and signs of pleural effusion, which was allowed to remain unrelieved. On the thirty-first day a fluctuating and pulsating swelling, the size of a pigeon's egg, was observed beneath the scar. It was punctured, but only blood came out. The patient sank and died on the thirty-seventh day. *Post mortem*, a "chronic pleurisy" of the right side, containing 9 or 10 pints of serum and blood; the lung was so packed against the spine as to be almost lost. The artery, cut half across, had given rise to a small aneurysm.

10. A man, aged 22, was stabbed over the third left costal cartilage; he became pale and cold, with a feeble pulse, vomiting, and much pain at the wound; he could not lie on the sound side. The surgeon made light of it, only bled and leeched him, and did not discover till the fourth day that the

second costal cartilage was cut clean through. On the sixth day, came a profuse discharge of pus and blood from the wound, increased pain, dyspnœa, and hectic fever. Venesection, calomel, antimony, etc., were employed. On the sixteenth day, severe dyspnœa, intense distress, œdema of the chest-wall; more venesection; leeches; death the next day. *Post mortem*, the second costal cartilage was divided and gaping; the pleura had been opened, and contained 60 or 70 ounces of pus and blood; the lung, compressed to one-sixth, was packed against the spine. The artery was cut half across.

11. A man, aged 30, was stabbed several times in the chest and abdomen. One of the wounds divided the fifth right costal cartilage, close to the sternum; severed the artery and one of its veins; opened the pleura, and just grazed the lung. The wound was closed at once; venesection and leeches were used; he died in twenty-four hours. *Post mortem*, more than a pint of blood-clot in the pleura; and the lung, not wounded, only just grazed, was reduced to one-third and packed against the spine.

These cases show clearly the difficulties and errors that await the surgeon who is called to treat a wound of the internal mammary artery. Shall he venture to trust to compression, or must he at once operate? Is the pleura wounded, and, if so, does the blood come from the lung, or the artery, or both? Is there a wound of the pericardium or of the heart? And if he must operate at once, what is the best method to follow?

His immediate diagnosis depends on the position of the wound, *plus* external hæmorrhage. But the wound may be oblique, or the cut ends of the cartilage may at once come together again; then the blood will flow into the pleura; or, if the pleura be intact, into the mediastinal space; or, if the pericardium be wounded, into that cavity. But blood in the pleura may come from the lung; blood in the pericardium from the heart. Again, the external bleeding may have stopped of itself; or

there may be room for doubt whether the artery really has been wounded at all.[1]

But since a partial wound of the artery is worse than a clean division of it; since the absence of external hæmorrhage is no proof that the artery has escaped injury; and since operation is in accord both with the principles of surgery, and with the teaching of those who have most studied the subject, the surgeon ought to operate, unless there be some good reason against it. The treatment of the hæmorrhage into the pleura or the pericardium—whether by incision, or by the promotion of absorption—need not here be considered.

The method of operation, as taught by Goyrand, is as follows: The incision, near the edge of the sternum, should be directed outward at an angle of 45° with the middle line. Its central point, over the intercostal space where the artery is to be tied, should be a quarter of an inch from the edge of the sternum. Skin, subcutaneous tissue, and pectoral muscle having been divided, the aponeurosis of the external intercostal muscle must be cleanly divided, the internal intercostal muscle must be scraped through, and the artery will then be found, a quarter of an inch from the sternum.

HÆMOTHORAX.[2]

Blood may be poured into the pleura either from a wounded intercostal or internal mammary artery, or from

[1] Gurlt, speaking of rupture of the artery in fracture of the sternum, says: 'A laceration of the internal mammary artery, or a superficial, not immediately fatal, injury of the heart, cannot be diagnosed with certainty; neither the symptoms nor the physical signs of mediastinal hæmorrhage are definite enough to lead us to any certain diagnosis.'

[2] In addition to authorities already given, see Pagenstecher, "Beiträge z. Klin. Chir.," 1895, xiii., 1, 264; and "Semaine Médicale," 1895, Nov. 13th and 20th.

a wound of the lung, the heart, the diaphragm, or the great blood-vessels. We have not here to consider these various injuries or their treatment, but only to note the signs and course of an effusion of blood into the pleura, and the treatment that it may itself require, apart from the wound that has caused it.

Hæmorrhage into the pleura, like other hæmorrhages, may be primary or secondary; it may be so furious, as in some gunshot wounds, that death is almost immediate; if it be not fatal at once, it makes itself known, in the worst cases, in a few hours, by all the signs of rapid and exhausting loss of blood, *plus* sudden ever-growing compression of the lung, and perhaps also displacement of the heart, *plus* the physical signs of a mass of fluid in the pleura, or of fluid in the lower part of it, with air above. The patient is restless, distressed, oppressed, unable to lie down, throwing himself into one attitude after another, fighting for his life; his face is blanched and sweaty, his lips livid; his breathing rapid, difficult, and laboured; his pulse rapid, small, irregular; he may know from his own sensations that he is bleeding inwardly, and blood may pour from the wound at every cough or sudden change of posture; his hands and feet grow cold, he has giddiness, noises in the ears, dimness of vision, faints, becomes unconscious, and dies.

In less rapid and less profuse hæmorrhage, the suffering is proportionally less acute, and the surgeon may even venture to watch the case without at once interfering. In these instances of gradual effusion, from penetrating wound of the chest, there has been observed, in some few cases, œdema or ecchymosis of the lumbar regions; and this condition was held by Larrey and others to be an important indication of the presence of blood in the pleural cavity. But it has been noted in

cases where there was no hæmothorax; and is usually absent even where there is profuse hæmothorax.

Apart from injury, hæmothorax may arise from aneurysm, from malignant disease, or from ulceration or erosion of tissues in tubercular disease, as where caries of a rib causes erosion of an intercostal artery. In such cases the onset of hæmorrhage is usually marked by severe pain, followed by oppression, dyspnœa, and other symptoms and physical signs such as I have already noted.

The course and treatment of hæmothorax after injury have been considered, to some extent, in the foregoing pages. We have now to consider what happens to blood effused into the pleura and not removed from it.

Many experiments have been made to ascertain the changes which occur in blood left undisturbed in the pleura. Wintrich (1854) found by numerous observations on rabbits, dogs, and cats, that complete absorption took place in two to eight days without leaving even a trace of pigmentation. The whole subject is fully treated by Pagenstecher, in a paper published last year, and his results are worthy of careful study. His method was to divert blood, by means of a simple transfusion apparatus, from the carotid into the pleura of the same animal. I give five of his observations:—

1. In a rabbit, blood was transfused from the carotid into the pleura for the space of two minutes. The animal was killed *two hours after*. The lung was already retracted; in the pleura were 14 cub. cm. of fluid blood, and one small clot.

2. In a rabbit, the blood was transfused till the pleura seemed quite full, and slight convulsions occurred. The animal died *five hours later*. The pleura was occupied by 11 cub. cm. of blood clot, and 5 cub. cm. of fluid. The lung, though compressed, was not wholly airless. The opposite lung was congested.

3. A similar experiment. The animal died *within twenty-four hours*. The pleura contained a huge blood clot,

lying over the lung, together with 10 cub. cm. of fluid. There was still some air in the lung: the lower lobe of it was ecchymosed.

4. A dog was transfused, by the same method, for two-and-a-half minutes. He was killed *at the end of twenty-four hours*. There was no fluid in the pleura: only a large non-adherent clot of great size. There was no sign of irritation of the pleura,

5. A dog was transfused until there were signs of dyspnœa. He was killed *on the seventeenth day*. The lung was found adherent to the chest wall and to the diaphragm by fine firm adhesions, in which was enclosed some altered blood clot; the pleural cavity was contracted; the lung contained air. The opposite lung was somewhat congested.

From these experiments alone it would seem that blood, effused into the pleura, becomes coagulated in a few hours. But careful analysis of the fluid and of the clots showed that their composition was slightly different from that of ordinary serum and blood-clot. And, from the following case, Pagenstecher believes that the changes in hæmothorax are of a special character, akin to the changes which occur in thrombosis in a vein: and that they depend on a damaged state of the pleura.

A man was severely crushed in a railway accident, and died three hours after it. Blood drawn from the pleura four-and-a-half hours after death, while the body was still warm, was still fluid, dark, and unmixed with clot; and it remained fluid even after several days' exposure to the air, forming an upper layer of clear reddish serum, and a lower dark layer of red blood-corpuscles. *Post mortem*, there was a large hole in the chest-wall, from which blood was flowing and the lung was protruding. In the pleura there were nearly two quarts of dark fluid blood, but no trace of any clot. The lung was compressed, but not lacerated. There were clots in a hæmorrhage in the anterior mediastinum.

It appears therefore that the pleura can keep the blood in it fluid, but still not unaltered; and that the process of coagulation may be compared to the process of thrombosis inside a blood-vessel. Absorption is, as a rule,

very rapid. In the first of Pagenstecher's experiments, the lymph-spaces of the pleura covering the diaphragm were already dilated, and contained whole or broken red blood corpuscles. Wisner injected olive-oil into the pleuræ of animals, and four hours later found minute emboli of oil in the lungs. But of course, in any patient, the work of absorption may be retarded by old pleural adhesions, or by a state of shock.

There is no evidence that the presence of blood in the pleura causes reactionary effusion of pleural fluid. Pagenstecher, in one of his transfusion experiments, also injected some atropine under the animal's skin. He drew off some of the transfused blood two hours after the operation, and again four hours after, and killed the animal eighteen hours after it, and collected the rest of the blood. None of the three specimens thus obtained showed the least admixture of atropine.

Nor is there anything to show that the pleuritic or purulent effusions, which so often follow hæmothorax, are due to direct irritation of the pleura by the blood contained in it. Probably, in these cases, the pleura is injured or infected at the time of the accident. This pleural effusion, marked by fever and by increase of dulness, without any symptom of renewed loss of blood, may occur at any time after the first twenty-four hours; and Wintrich has recorded a case where it occurred as late as the sixteenth day. If it be not purulent, it usually disappears without surgical treatment.

But it is to be observed that this effusion after hæmothorax does not always behave like a common pleural effusion; it follows an unusual set of conditions, and is likely to run a course of its own. Tuffier[1] has lately

[1] "Semaine Médicale," Nov. 20th, 1895.

called attention to the difficulty of knowing when to interfere in these irregular and uncertain cases of pleural effusion after hæmothorax. He gives three from his own experience, illustrating their tendency to deviate from a regular course. In the first case, a student, aged 20, shot himself in the left side of the chest, and the injury was followed by hæmothorax. On the third day he became feverish; on the fourth, his temperature rose to 104, and Tuffier punctured the chest, but drew off only a few drops of fluid, which, on testing, were found perfectly sterile. Nothing further was done; the patient made a complete recovery. In the second case, a girl, aged 18, shot herself in the right side of the chest, and the injury was followed by hæmothorax. On the sixth day she became feverish, and her temperature rose above 103. Nothing was done; complete absorption followed without further trouble. The third case was like the other two, except that the rise of temperature did not occur till the eighth day. Nothing was done; complete absorption followed, and the patient made a good recovery.

We must remember that in cases of injury there is usually air, as well as blood, in the pleura, leading us to anticipate a tendency to suppuration.

Something has already been said about the treatment of hæmothorax, but a few points remain for consideration. First, unless there be signs of serious or increasing pressure on the lung, the surgeon should hold his hand, in the belief that the blood will be absorbed and turned to good account, instead of being lost by withdrawal from the body. Next, if he must operate, he should be prepared to transfuse the patient immediately after operation. And, if the aspirator fails to give relief because it gets blocked with clot, he must incise the

chest. Finally, he must not attempt to withdraw all the blood at once, lest he excite fresh hæmorrhage. Not that the original hæmorrhage is stopped by the actual pressure of the effused blood on the bleeding point: this could not happen unless the whole side of the chest were loaded with a huge effusion under high pressure: but lest a too vigorous use of the aspirator should loosen some wound in the lung just healed.

CHAPTER IX.

WOUNDS OF THE LUNG.

THE way is now cleared for consideration of the chief facts in wounds of the lung; but the subject is so great that we cannot hope to see all sides of it, and many pages might be given to treatment alone, in view of the work of the last few years. It may be convenient to consider first the general difficulties of dealing with a wounded lung; next the usual character and course of such wounds; and then the limits and possibilities of treatment.

In the first place, the case has probably a medico-legal side to it. Hence, the surgeon must lose no time in noting carefully the whole scene, the position and condition of the patient, the shape, size, and staining of the weapon, and the exact character and measurement of the wound. Before any further steps are decided upon, external hæmorrhage, if present, must be checked, at least temporarily, by firm pressure; and the worst of the shock must be overcome with warmth to the extremities, hypodermics of strychnine, and careful stimulation.

Next, the difficulty of examination is much increased by the necessity for absolute and complete rest—'*immobilité absolue*,' the forbidding of all movement, the scrupulous avoidance of all handling of the patient, that is not really necessary. What Rose[1] says of wounds in the region of the heart applies, almost as strictly, to the lung.

---

[1] "Herztamponade: ein Beitrag zur Herzchirurgie"; "Deutsche Ztschr. f. Chir.," 1884, xx., 329.

"Certainly the worst thing of all for the patient is 'thorough examination.' We have got past that bad time in surgery, when a man would not leave a fractured pelvis alone till he had made it crack, or, as he called it to pacify the patient, till he had established beyond doubt the presence of crepitation. Why should we treat cases of internal wound or injury worse than we now treat a fractured pelvis? In all such cases, I avoid all repeated examinations; I make the examination with all gentleness; I never probe the wound or put my finger in it. I percuss the patient softly, do not ask him to breathe hard during auscultation, and prefer not to listen to his back, rather than set him up in bed without some special reason, or disturb by any movement the delicate half-formed adhesions, which are our chief hope of his recovery. But there are still cases where, in spite of all my warnings and orders, these rules are broken, and the excessive zeal of some of my assistants for accurate diagnosis has retarded healing and brought the patient into grave danger of death."

The two following cases bring out this point[1] :—

1. A young man, while fencing, was wounded near the right axilla with a foil without a button; he began to cough blood very freely at once, even before he could take off his mask. He was immediately laid flat, forbidden to move, to make any effort to clear his throat, or even to take a stimulant. Three hours later, a little iced champagne was given; low diet; a purge on the third day. The hæmoptysis did not recur; an effusion into the pleura, probably blood, was slowly absorbed. He was kept at the gymnasium for six weeks before he was allowed to leave his bed and go home. Complete recovery.

2. A young man, in a duel, received a thrust under the pectoralis major in the third right intercostal space. The

[1] "De l'immobilité absolue du blessé comme condition essentielle du traitement des plaies pénétrantes de poitrine par arme blanche," "Semaine Médicale," Feb. 6th, 1895.

sword was stained with blood for more than a third of its length. He was removed a long journey to Hospital, repeated injections of ether and of ergotin being made on the way. He was not got to bed till two hours after the accident; then he was stripped, and a prolonged examination and dressing of the wound were made. In a very short time, a frightful hæmorrhage came from his mouth, and he died. *Post mortem*, there was a wound of the whole depth of the lung, but no great vessel had been divided.

The contrast between these two cases suggests to us that one thus wounded should be kept flat, not raised for auscultation, forbidden to move, to speak, even, if he can help it, to cough or clear his mouth. His clothes should be cut off, not taken off. All food must at first be withheld. The wound must be dressed without moving him, so far as possible.

But even if the surgeon is prevented by the critical condition of the patient from making a thorough examination of the wound, and from complete auscultation and percussion of the chest, he has other evidence to guide him as to the probable depth of the wound and the extent of the harm done to the lung. Concerning emphysema and pneumothorax, something has already been said. The presence of either or both does not prove that the lung has been wounded. The pleura can be opened, and yet the lung escape; a bullet may be deflected from it by a rib, or an incised wound may be so oblique as to open the pleura and yet barely graze the lung; or the weapon, *e.g*, a billhook or a scythe[1], may be blunt of one edge and curved, thus pushing the lung aside without cutting it. Or the injury of the lung

[1] In "Casper's Forensic Medicine," 1860 (Syd. Soc. Transl.), i., 165, there is a case of a scythe-wound, 8 inches long, opening the pleura, but not wounding the lung. And the two famous cases of a carriage-pole, and of a mast-end, passing through the chest without causing death, are also instances of the lungs being thrust aside but not lacerated.

may be too slight to cause symptoms during life, or to leave a scar after death.

We have to consider here those wounds that afford clear evidence of lung injury; and this evidence is hæmorrhage, external through the wound, effused into the pleural cavity, running into the bronchi, escaping through the mouth; the signs of loss of blood—pallor, bloodless tint of the lips, faintness, quick feeble pulse, hurried sighing respiration, cold hands and feet, and marked restless oppression and sense of impending dissolution; and the physical signs of effusion.

Rapid effusion of air into the pleura may give signs not unlike these; but it has also distinctive signs of its own. The effusion of both air and blood together may confuse the picture, but does not wholly prevent the surgeon from estimating the source and extent of the bleeding. Let us then take by itself the hæmorrhage from wounds of the lung; excluding hæmorrhage from the heart and the great vessels.

Hæmoptysis.

There are many ways in which we may fail to estimate hæmoptysis aright. It may follow a blow on the chest, whereby the lung is concussed or contused, but not lacerated; as we have seen in the chapter on fracture of the ribs.

A young man, aged 21, a tall, slender recruit, was accidentally struck on the left side by one of his comrades. This was followed by copious hæmoptysis. There was no fracture. Large moist crepitations were heard on auscultation. He continued to cough up blood, at intervals, for three days, and then rapidly recovered.[1]

Or it may follow a gunshot wound, where the bullet,

[1] "Hist. Amer. War," pt. i., Surg. Vol., p. 637.

having pierced the pleura, has been deflected by a rib, grazing the lung, but not wounding it.

> 'I have traced a ball by dissection, passing into the cavity of the thorax, making the circuit of the lung, penetrating nearly opposite the point of entrance, and giving the appearance of the man having been shot fairly across, while bloody sputa seemed to prove the fact. The bloody sputa, however, were only secondary, and neither so active nor alarming as those which pour at once from the lung when wounded.'[1]

Or it may come from an unsuspected phthisical cavity in the lung, as in a case recorded by Dr. Cayley,[2] of a police constable, aged 20, 'always strong and healthy,' who, a few hours after receiving a violent blow on the right side of the chest, had a profuse hæmoptysis; and then, for the first time, there were found signs of tuberculous disease of the right apex. Or it may be due to some trivial wound or sore in the mouth or upper air passages; as in a case lately under my care, a young man run over, whose hæmoptysis came simply from some raw patches at the back of the throat. Nor must we forget that the account of hæmoptysis given by the patient himself is generally exaggerated; and that it is a common trick of malingerers.

The absence of hæmoptysis gives us no assurance that the lung has not been wounded. This is especially true of gunshot wounds, which tear or break the lung, but do not make a clean cut into it. And cases have been given (chap. iv.) of extensive laceration of the lungs from crushing of the chest, in which there was no hæmoptysis. In St. George's Hospital Museum, there is a specimen of laceration of the lung, four inches long and two deep, but no hæmoptysis followed it. Of the cases

---

[1] Hennen, "Principles of Military Surgery," 1829, p. 372.
[2] "Clin. Soc. Trans.," 1874, vii., p. 89.

of gunshot wound of the chest carefully observed in the Crimean War by Dr. Fraser, only one out of nine fatal with wound of the lung had hæmoptysis, but of seven fatal cases, in which the lung was not wounded, two had it, and of twelve not fatal, three. Out of 8,715 penetrating gunshot wounds in the American War, hæmoptysis was noted in 492, only 5½ per cent.; but probably in many other cases it occurred, and was not recorded.

We cannot, therefore, form any very sure conclusions as to the state of the lung from the presence or absence of hæmoptysis alone; at least, so far as gunshot wounds are concerned. But if it be somewhat profuse and persistent, and apt to be increased by the coughing or sudden movement or exertion of the patient, and if the blood be frothy with air, and come soon after the injury, we may be practically certain that the lung has been wounded.

Hæmorrhage into Pleura.

Next, as to hæmorrhage into the pleural cavity, this may be either primary or secondary, rapid or slow. The symptoms of internal hæmorrhage, the physical signs of a large effusion of fluid in the pleura, or of fluid below and air above, may be present almost at once, or may gradually grow more marked till the patient is at the point of death; or may reach to some height, and then, under treatment, may improve. The following cases[1] are good instances of the worst sort of internal hæmorrhage into the pleura without marked external hæmorrhage:—

1. A boy, aged 14, was stabbed in the back with a knife; a few minutes afterward, he fell fainting on the floor;

[1] Casper, *loc. cit.* i., p. 122: and Quénu, "Semaine Méd.," Nov. 13th, 1895.

he died in six hours. *Post mortem*, the wound was small, clean, soft, dry, free from any trace of ecchymosis, "just such edges as would have existed in a wound made on a dead body." The knife had gone an inch and a half deep into the lung, and in the pleura were 4 pounds of dark fluid blood, with some coagula.

2. A man was stabbed in the second right intercostal space, far back, near the inner border of the scapula, and died in three-quarters of an hour. *Post mortem*, the wound was small, clean, smooth, dry, white, wholly without ecchymosis. The upper lobe of the lung was perforated, and in the pleura were a quart and a half of dark fluid blood, partly coagulated.

3. A young man, aged 19, was admitted to Hospital with a penetrating wound of the seventh left intercostal space. It was sutured by the house-surgeon on duty. 'I saw him next morning, and was struck by his extreme pallor, and found all the signs of a large pleural effusion. I punctured the chest, and drew off 18 ounces of almost pure blood. A week later, I again punctured him, and drew off more than 3 pints, almost all blood. Next day, in view of the persistent gravity of his symptoms, I cut the stitches, enlarged the wound, resected the seventh rib, and having ascertained that the bleeding did not come from the intercostal artery, I made a free incision through the pleura, and found the lung retracted far back against the spine. I turned out several clots from the neighbourhood of the wound of the lung, and put in a plug of iodoform gauze. No more hæmorrhage occurred; the cavity filled up very quickly, and the patient was discharged in a fortnight.'

It is the same internal hæmorrhage, in gunshot wounds, that accounts for a great number of deaths on the field of battle: as Riedinger describes them:—'Many, the moment they are shot, fall and give no further sign of life; many are left for dead on the field, yet revive; the wounded are pale and wretched, their lips livid, foreheads covered with sweat; they suffer pain in the chest, cough, faintness, vomiting; their breathing is shallow, rapid, and difficult; some are restless, others lie unable to move; convulsions, obscuration of vision, excitement, may be noted.' The mortality from such wounds, in time of

war, is probably not less than 60 per cent. of all chest-wounds classed as penetrating, and much higher than this for actual gunshot wounds into the lung. After Sedan, Sir William McCormac reported that of 54 cases treated at the Anglo-American Ambulance at Asfeld, 31 were regarded as penetrating, of which 17 died. From Metz, Dr. Fischer reported 78 cases, of which 34 were perforating gunshot wounds; of these 34, 19 died. From Strasburg, Dr. Beck reported that out of 98 fatal gunshot wounds of the chest, 24 deaths were due to hæmorrhage alone.

Hæmorrhage from the Wound.

Finally, we have to consider external hæmorrhage. Going from without inward, we must first note that bleeding may possibly come from a severed vessel outside the ribs; the long thoracic, or the subscapular artery, may be wounded; but such injuries are very rare. Wounds of the intercostal and internal mammary vessels have already been discussed. A wounded intercostal artery may bleed profusely into the pleura, with no marked external bleeding. By what signs, then, may we know, from the external wound, whether the lung itself is bleeding? The passage of air in and out of the chest, or its being forced out on coughing, the 'characteristic mucous bubbling,' is no sure sign. It is usually absent, especially when the external wound is large; and when present, the air may yet be driven in and out from the soft tissues (emphysema) or from the pleura, and not come from the lung at all. If we can, from the position and direction of the wound, exclude all probability that an intercostal or internal mammary artery has been divided; if other signs of wounded lung are present, and blood is collecting in the pleura, and running from the

wound when the patient coughs or struggles, we may feel sure that it comes from the lung itself, especially if the finger, passed into the wound, feel no jet of blood from the neighbourhood of the intercostal artery.

General Treatment of Wounds of the Lung.

Difficult indeed is the treatment of these cases—'a mighty maze, but not without a plan.' Watching the case from hour to hour, what indications for treatment may we hope to observe? Too great stress cannot be laid upon the necessity of staying with the patient and watching him closely.

The immediate duty of the surgeon, to check the external bleeding, and to tide over the worst of the shock, has already been discussed.

As regards the use of the probe there is some difference of opinion.

It is easy work to collect warnings against its use. In an incised or punctured wound it is better not to use it.[1] It is in gunshot wounds that the probe may be needed, but perhaps not at first. And even here, as we see from

---

[1] In such cases it may do positive harm, even if the information it gives is correct, and this is not always the case. The following case illustrates this point:—A prisoner in the American war was wounded by a sentinel with a bayonet in the right side of the chest, four inches from the spine and two inches below the angle of the scapula. "On examination with the probe, I found that the probe ran down beneath the skin for two or three inches, but was unable to detect any opening into the thorax. . . After a consultation, it was concluded that it was a non-penetrating wound of the chest. . . . Toward morning he became delirious, and died about sunrise." *Post mortem*, the whole pleura was full of blood; the lungs were not injured; the bayonet had penetrated the heart (posterior aspect of left ventricle), and had probably also wounded the vena cava inferior.

An instance of harm done by probing a knife-wound is given on page 74.

the case[1] reported by M. Péan, at the Surgical Congress last year at Paris, its use may lead to bad results, even when there is reason to hope that the bullet is not out of reach. Authorities indeed are by no means agreed among themselves on the point. Thus, in opposition to Dupuytren, Pirogoff, Gross, Erichsen, and others, we find Demme saying that the fear of a careful examination is entirely unfounded; while Legouest maintains that Dupuytren's teaching is not in accord with the facts of the case; the worst that can happen, in probing for a bullet, is to fail to find it; the lung is either retracted out of reach of the probe, or adherent to the pleura, so that the probe will keep in the track of the bullet and do no more harm than has already been done. From the records of military surgery, and the teaching of most authorities, we may fairly conclude that its careful use, after the first day or two, is in some cases advisable. 'The surgeon will gain all the information he can from observing the external wound, using his finger, as far as he judges prudent, to determine the extent of the wound and the presence or absence of foreign bodies, but not employing the probe in early examinations. . . . There is a wide difference between rash and unwarrantable

[1] The following case is given by him. A man, aged 45, a drunkard, shot himself with a revolver over the heart, in the fifth left space. The injury was followed by dyspnœa and hæmoptysis; the heart-sounds could hardly be heard, and there was extensive dulness over the base of the left lung. "In spite of these alarming symptoms, and of an extensive pleurisy, he quickly improved, and his recovery seemed certain, till, in disregard of my directions, one of our house-surgeons took it into his head to remove the bullet, which could be easily felt lying near the sixth dorsal vertebra. In spite of the strictest use of antiseptic dressings, a phlegmonous inflammation appeared next day round his incision, the effusion in the left pleura became purulent, a purulent effusion occurred in the right pleura; and all our endeavours failed to save the patient's life."

explorations, and the judicious use of the probe and forceps in cases in which there are just grounds for suspecting the presence of a foreign body; and the sagacious practitioner will neither discard the probe absolutely nor use it habitually. It is almost needless to repeat that all good surgeons agree that the finger is the best probe whenever available.'

Having thus, as it were, got our patient over the first shock, checked the external hæmorrhage, and so far as permissible examined the wound, other questions arise. How shall we dress the wound? Of the old 'hermetical sealing' of the wound, there is nothing favourable to be said; it received full trial, and was found to be a mistake. A clean-cut incised wound should be closed; this will prevent, perhaps, the occurrence of pneumothorax and collapse of the lung; and to leave the wound open will not prevent emphysema. And the chest must be so far as possible immobilized with a carefully adjusted broad bandage, or a binder of flannel fastened down the front. In gunshot wounds, a long strip of iodoform gauze, gently pressed into the wound, will prove as good as any other first dressing.

Of the absolute necessity of rest I have already spoken. In most cases it will become necessary to ensure this by means of morphia.[1] Of the influence of posture, to allow the effused blood to escape, many instances might be quoted. Perhaps the most striking of them is the case of a wounded soldier, supposed to be dead, who

[1] In the case of a soldier in the American war, in whom an explosive bullet had shattered the pectoral muscle, and then entered the chest, opisthotonos occurred a fortnight after the injury, and he was thought to have tetanus. "Opium was administered, and carried to the point of narcotization. The pupil was contracted to the size of a pin-hole during the whole treatment." He made a complete recovery.

was carried off the battlefield, slung anyhow over a comrade's shoulders; this rough treatment brought about a sudden rush of blood and air from his wounds; he revived, and finally recovered. In other cases, the later accumulation of serous or sero-purulent fluid in the pleura could be relieved, day after day, by the patient placing himself or being placed in such a position that it could be poured out of him. Further examples of this influence of posture are given in the chapter on empyema, and on pages 48 and 96.

Operative Treatment.

Of all penetrating wounds of the chest, it may be said that they must only be closed, provided the surgeon be at hand to reopen them, if necessary. Mere compression of the lung by the blood effused will tend to arrest bleeding. Puncture or aspiration may be necessary. But if the bleeding still goes on, then the surgeon's last resource must be an operation, freely exposing the lung, and enabling him to plug or suture the wound in it, or apply a ligature at the source of hæmorrhage. As regards this operation, in addition to M. Quénu's case (see 'Hæmorrhage into Pleura'), the three following cases[1] (1885, 1893, and 1894) illustrate with what degree of success this dangerous measure may be carried out.

1. A man, aged 20, shot himself with a revolver in the left side of the chest; there was extensive hæmorrhage into the pleura, with grave collapse of the patient An incision, five inches long, was made through the third intercostal space; a great quantity of blood was let out; a wound was found in the lower edge of the upper lobe of the lung. The lung was drawn forward; the wounded portion was

[1] Omboni of Cremona, Delorme, and Michaux. For references, see discussion on Reclus' paper, Congrés Francais de Chirurgie, 1895.

secured with a double catgut ligature passed beneath it, and removed. There was also a bleeding point in the lower lobe; this was closed with catgut sutures, but one of them gave way, and finally a ligature was applied. The patient did well at first; but the wound suppurated, and he died.

2. An officer in the army stabbed himself four times over the heart with an amputating knife; he lost a very great quantity of blood, and was taken some distance to a Hospital, where the wound was cleansed and closed. The next two days the bleeding went on, and he was in danger of death from exhaustion. A free opening was now made into the pleural cavity; three wounds in the lung, and two in the pericardium, were found and closed. The patient had lost an enormous quantity of blood before the operation, and died a quarter of an hour after it.

3. A young man, aged 18, shot himself with a revolver in the left side of the chest, about an inch outside the nipple, and was at once admitted to Hospital; he was conscious; the external hæmorrhage was nothing; there was no marked feeling of oppression; the house-surgeon closed the wound with a collodion dressing. 'Next morning, going my rounds, I find him, twelve hours after the injury, in acute suffering, very pale, with oppression, and a sharp pain in the side, making all movement of the chest impossible. Examination reveals complete dulness over the lower two-thirds of the left side of the chest, with complete loss of vocal vibrations, and well-marked œgophony; it is, therefore, impossible to doubt that there is a profuse hæmorrhage into the left pleura. Fearing to be too hasty in interfering, I decide to wait a little longer, and to see if he improves during the day; I see him again in the afternoon; his general condition is worse, the dull area seems larger, his oppression is intense; face pale and distressed, pulse small, temperature 100·4; I hesitate no longer, and operate at once." The wound was thoroughly cleansed and examined; a large U-shaped flap of skin and muscles was turned upward; the seventh and eighth ribs, three or four inches of each, were resected; the intercostal muscles and the pleura were raised as a flap, following the line of the skin and muscle flap; the divided intercostal arteries were secured. A quantity of blood and air escaped from the pleura; the blood, fluid and clots together, came to nearly a quart; the lung and the pericardium were freely exposed to sight and touch. There was no wound on the surface of the lung, but blood kept trickling down from its inner surface, and, on turning outward the

anterior edge of the lower lobe, M. Michaux got a good view of the bleeding point, on the inner aspect of the lung, below its root, close to the lower border of the pulmonary vessels. Since the bleeding was not very free, and since he feared that by using the catch-forceps he might obliterate some important vessel, he simply plugged the bleeding part with iodoform gauze, bringing the end of the gauze outside the chest: he put in two large drainage tubes, and sutured everything in its place. The operation took less than half-an-hour. A week after it, slight suppuration occurred. The patient made a perfect recovery.

In relation to these most valuable cases, we may take the opinions expressed on M. Quénu's case last year, at the Société de Chirurgie (Nov. 6th, 1895). M. Delorme said that in a case of persistent hæmorrhage, one ought without delay to open the chest; and if the opening of the wound in the lung were too small to admit a plug of gauze, one ought to enlarge it sufficiently to plug the wound from the bottom. M. Michaux and M. Berger were both in favour of operation in such cases; but M. Lucas-Championnière thought that the modern tendency to interfere in cases of hæmothorax after wound of the lung is carried too far; and that in most cases, absolute immobilization of the chest will stop the bleeding, and the least disturbance of the patient may prolong it and cause death.

And certainly the following cases[1] seem to show that no hæmothorax can be so severe that it may not of itself stop just short of death.

1. A young officer, in a fit of melancholy, shot himself in the left side of the chest. 'I found him in a desperate state, almost pulseless, half-conscious, pale, shivering, his forehead covered with sweat, eyes sunken, lips blue, breathing irregular and laboured; there was dulness over the whole side of the chest, and the heart was pushed over to the opposite side. I very thoroughly cleansed and disinfected the

[1] Riedinger, *loc. cit.* Jonnesco, "Congrès Fran. de Chir.," 1895, p. 99.

entrance-wound, and applied a well-fitting dressing, and kept him flat. He gradually came to himself, accepted the situation, and lay perfectly still. With each fit of coughing, he spat up a considerable quantity of blood.' The hæmoptysis ceased in a few days; the blood was absorbed; and he made a complete recovery. The bullet was removed from his back, a year later.

2. An officer, in a duel, received a sword-wound in the second right intercostal space, wounding the lung. There was free external hæmorrhage; he had two attacks of syncope, and suffered intense dyspnœa. That evening, he had two slight attacks of hæmoptysis, and next day there was an enormous effusion of blood in the pleural cavity and absolute dulness of the right side. An exploratory puncture drew off pure blood. No operation was done; the hæmoptysis ceased on the third day, and the blood was all absorbed in about a fortnight.

Thus the matter stands; at any rate, we must be prepared, should all other measures fail, to attempt to find and secure the wound in the lung, for we must remember Ch. Nélaton's statistics[1]. Of 86 cases of penetrating wound of the chest with hæmorrhage into the pleura, only 22 recovered without operation; 20 were treated by puncture or incision of the chest, to relieve the pressure of the effused blood, and 4 of them died; 44 died of the hæmorrhage, without operation.

Of the later or ultimate troubles that may follow a wound of the lung, some are described elsewhere; others offer no opportunity for surgery. As to the removal of foreign bodies after the patient has recovered from his wound, each case must be decided on its own merits. So far as I know, the Röntgen rays have not yet been employed for this purpose: and Von Bergmann has recently warned us that, even if a foreign body can be exactly localized by means of them, it may still be wrong to interfere with it.

---

[1] Ch. Nélaton: "Thése de Paris," 1880.

CHAPTER X.

WOUNDS OF THE HEART.

SURGERY of the heart has probably reached the limits set by Nature to all surgery: no new method, and no new discovery, can overcome the natural difficulties that attend a wound of the heart. It is true that 'heart suture' has been vaguely proposed as a possible procedure, and has been done on animals: but I cannot find that it has ever been attempted in practice. (*See* the chapter on "Pericardial Effusions.") There is a great quantity of very careful clinical records of heart-wounds, and of foreign bodies in the heart: especially the very valuable monographs by Purple,[1] Fischer,[2] Stelzner,[3] Riedinger, and Rose.[4]

HISTORY.

Fischer, reviewing the whole history of wounds of the heart, begins with a fact noted in the Iliad of Homer, that a foreign body in the heart may be observed to move with the heart's movements.

> 'He fell: the spear-point quivering in his heart,
> Which, with convulsive throbbing, shook the shaft.'[5]

---

[1] Wounds of the Heart, "New York Journ. Med.," 1855, p. 411. Analysis of 42 cases.

[2] Die Wunden des Herzens und des Herzbeutels. Langenbeck's Arch., 1868, ix., pp. 571–907. Analysis of 452 cases.

[3] Deutsche Ges. f. Chir., 1887, i., p. 58.

[4] Hertamponade: ein Beitrag zur Herzchirurgie. "Deutsche Zeitschrift fur Chir.," 1884, xx., p. 329-410.

[5] Lord Derby's Translation, xiii., 498.

But since Hippocrates taught that all wounds of the heart are necessarily fatal, since Aristotle and Pliny contended that the heart is so essential to life that it never suffers disease,[1] and Fallopius declared that if it were wounded it could never heal, being too hard, always in motion, and of an inflammatory heat, we cannot wonder that little attention was paid to such wounds before the end of the 17th century. Those most in advance of their times in the earlier centuries were Albucasis (1100), who advised that one should cut down on an arrow-head in the heart; Sanctorius (1560), who made some experiments on rabbits; Hollerius (1500), who taught that a wound of the heart is not necessarily fatal; and Wolf (1640), who gave the first positive description of a healed wound of the heart. Forty years or so before Wolf, Zacchias published the first case of a needle in the heart: the patient died on the sixth day, 'because the noblest organ in the body cannot survive a solution of its continuity.' In the 18th century, the observations began to be more numerous; and in 1760 Morgagni first pointed out the vital fact, that death is mostly due to compression of the heart by the blood effused into the pericardium. In 1800, Richter spoke against the use of the probe, and showed how, by keeping the patient still, and applying leeches, one might hope to keep the wound sealed with a clot. Among those who came after Richter, the names of Larrey, Dupuytren, Jamain, and Zametti are especially to be noted. Except for Guthrie (1848), the subject has been more studied in other countries than in England.

As regards experiments on animals, many observations have been made from time to time: the more important

[1] Solum hoc viscerum vitiis non maceratur, nec supplicia vitæ trahit. Læsumque illico mortem affert.

are those of Jung (1835), who demonstrated by acupuncture that the heart wall is little sensitive to pain, and observed the lowering of the pulse on the introduction of the needle: those of Virchow, who demonstrated the same indifference to pain on stimulation of the cavities of the heart; those of Castelnau and Ducrest, who observed the passage of small foreign bodies from the saphena vein into the right ventricle; and those of Block (1882), and Watson (1887). One may also count among experiments on animals the many instances where foreign bodies, shot or bullets, have been found encapsuled in their hearts: a fact demonstrated so far back as 1600 by Weber.

Such are the chief landmarks in the history of the surgery of the heart: tradition and imagination stood in the way of it for centuries: and when we come to the history of the operation for empyema, we shall again see the same conflict between authority and clinical facts.

General Course.

That a gunshot wound of the heart is, in nearly every case, at once fatal, may be seen from the fact that during the whole of the American War only four cases came under treatment. Larrey is said to have had seven cases: but these all occurred in civil practice, not in war. Dupuytren is said to have had eleven cases. Death from a gunshot wound of the heart may be apparently instantaneous, but as a rule there is some sort of automatic movement at the moment—a gasp for breath, or a word or two, or a convulsive action — but the popular notion of persons springing up in the air, when shot through the heart, is not verified by facts. The manner of death is doubtless due to the immediate stoppage of the

heart by the rush of blood into the pericardium, not to inhibition of the vital centres by shock. Of the four cases recorded in the American War, which were not at once fatal, one patient lived just over an hour; one, who had also other wounds, lived about two days; one lived fourteen days, and then died suddenly; one lived two and a half years, and then died of softening and rupture of the right auricle.

Of survival after stab-wound of the heart there are many instances, and needles have often been found *post mortem* in the hearts of patients. As in wounds of the lung, so here, there is generally a medico-legal aspect of the case: and the grave question may be raised between suicide and murder. Thus, the direction of the wound must be considered, as in a case recorded by Casper,[1] where a man was stabbed over the heart with a pocket-knife. The defence was, that he had run in on the other man's knife; but there were two wounds, they ran from above downward, and converged toward the heart: and on this evidence the accused was condemned. In another case, a man was found dead, shot through the heart: the bullet, entering an inch and a half from the left nipple, and passing out at the back two inches from the ninth dorsal vertebra, had torn open the left ventricle, then passed through the diaphragm, and wounded the upper edge of the spleen. His left hand had dried blood on its palmar aspect, and there was a small wound of the index finger, with fracture of the first phalanx. He had therefore shot himself with his left hand, pointing the weapon downward.

In a case of gunshot wound, the position, in which the body was found lying, gives us no sure means of

[1] Forensic Medicine, "Syd. Soc. Transl." 1868, i., p. 192.

distinguishing between murder and suicide. A more sure sign is given if the hand be found firmly grasping the weapon: in one or two cases it has been necessary even to saw through the fingers to remove it. A murderer might put the weapon into his victim's hand, and close the fingers over it; but it has been proved that *rigor mortis* cannot imitate this firm spasmodic grasp: a rare, but sure sign of suicide. The presence of a second gunshot wound, in the head, or elsewhere, in addition to a penetrating wound of the heart, is not conclusive evidence of murder: there is more than one recorded case where a man has shot himself first through the heart, and then elsewhere.[1]

It may be worth while here to mention a case[2] of wound of the heart, which had a medico-legal aspect of a very different kind. It happened seventy years ago. The patient died, and the surgeon was put on his trial for malpraxis. 'The treatment throughout was faulty: no venesection, or antiphlogistic remedies; but on the contrary, in three days from receiving the wound, nourishing diet, bark, etc.' The wound of the heart was held to be not necessarily fatal, and the treatment vicious and faulty.

Perhaps this verdict was not wholly wrong: it is impossible to be too careful to keep the heart beating quietly: not only at first, but even for weeks after the injury. Long after the patient seems out of danger, the very slightest exertion may cause immediate death.

[1] In one case, the patient was allowed to walk about on the fifth day; and the day after, while walking, he suddenly

---

[1] Agnew, American Surgical Association, 1887, v. p. 243.

[2] Judicial enquiry upon a person who died after ten days, from a wound of the heart. *Neurohr*, 1825

fainted and died. In another, the patient had been allowed to go back to school; and three weeks and a half after the accident, he fainted and died. In two other cases the patients died suddenly in the act of defæcation.[1]

A man had been struck with a knife in the region of the heart. On the fourth day, he was at the window of the Hospital when he saw his assailant pass by: he became greatly agitated, and in a short time died. *Post mortem*, the heart was found to have been wounded.[2]

A leading man[3] whose death occasioned much excitement in New York in 1885 was shot in the heart, and lived for nearly twelve days. He suffered no attacks of syncope: there was no palpitation or irregular action of the heart. 'From the time of the reception of the wound to its fatal issue, he was surrounded by most exciting and disturbing influences, both physical and moral . . . . . Under more favourable circumstances, there seems but little doubt that he might have recovered.' *Post mortem*, the bullet was found encapsuled in the septum ventriculorum, an inch and a half from the apex, and a quarter of an inch from the surface. The heart was covered with fibrinous lymph: there were 30 ounces of sero-sanguinolent fluid in the pericardium.

A private in the American War received a gunshot wound; the bullet fractured the lower jaw, tore the tongue, and passed down the neck into the chest. The jaw was comminuted, suppuration occurred, and the case was condemned as hopeless. 'He persisted in sitting up, and would occasionally attempt to make up his bed and walk about the room when not restrained. He died suddenly, fourteen days after the injury.' *Post mortem*, the ball had penetrated the right auricle, and was lying loose within the heart. There were signs of pleurisy and pericarditis, but these had not been noted during life.

Here then are seven instances, in a group of cases so rare as penetrating wounds of the heart not at once fatal, where death was hastened or caused by want of absolute, long-continued rest, for many weeks.

It goes without saying that the use of the probe in

---

[1] Purple, *loc. cit.*

[2] "Nélaton's Lectures on Surgery," Atlee, 1855, p. 57.

[3] "New York Medical Times," April, 1885.

these cases is not the way to begin to save the patient's life.

A man,[1] aged 24, shot himself in the heart. 'I was called in haste to the case by the surgeon who had first seen him, on account of the hæmorrhage. At first he had lost hardly any blood, but after the probe had been introduced into the wound he had begun to bleed freely. The surgeon assured me that the probe had not been passed deep, and had not done any more harm than had been done by the bullet; anyhow, the bright-red blood running from the wound showed some serious injury.' The patient was violently excited, and kept tearing off his bandages. He was bled freely, and watched day and night; but he persisted in tearing at his bandages, even when he was fastened hand and foot. He died on the twelfth day, of pneumonia. *Post mortem*, septum ventriculorum perforated, edge of left lung wounded, left pleura full of blood. 'One gets more and more certain, as one sees the same thing happen again and again, that the use of the probe in wounds of the chest never does any good, and often, as here, does a great deal of harm.'

As to the general chances of wounds of the heart of all kinds, Fischer's 452 cases are as follows: wounds of the heart, 401; wounds of the pericardium alone, 51. Of the 401 wounds of the heart, about nine out of ten went through the whole thickness of the wall of the heart. Of the 51 wounds of the pericardium alone, 38 were uncomplicated, 13 were complicated with wounds of the great vessels. The different regions that were wounded show the following percentage: right ventricle, 27·2; left ventricle, 22·2; both ventricles, 5·7; right auricle, 6·2; left auricle, 2·8. The coronary artery may be wounded with the heart: one case only is recorded where the artery was wounded, but the heart escaped.

It is strange that the internal mammary artery seems always to escape injury in heart wounds. I can find no recorded case where it is certain that they were both

[1] Rose, *loc. cit.* p. 335.

wounded; and should this happen, the exact diagnosis would be impossible, unless, as in a case recorded below, it could be suspected from a rapidly occurring hæmothorax in a case not immediately fatal: nor is it probable that any treatment would avail to save the patient. Wounds of the left pleura and of the border of the lung are, on the other hand, the common accompaniment of wounds of the heart. In 13 out of Rose's 16 cases, the lung was wounded. From the wounded lung and pleura, air passes into the wounded pericardium (pneumopericardium) and from the pericardium blood may run into the pleura. An exact diagnosis must needs be difficult or impossible. Most of the symptoms may raise a fear that the heart itself is wounded, but may not prove it: and the mere fact that the patient is alive, goes against a positive opinion that it is.

Diagnosis.

Diagnosis may be assisted by the signs of effusion of blood, or of blood and air, into the pericardium: the action of the heart may be feeble or tumultuous, there may be marked pleural or even pericardial dulness, or abnormal heart-sounds. Thus, in a case in the American War, the action of the heart was weak and tumultuous, and the left side of the chest exhibited marked dulness, indicating effusion of blood into the left pleural cavity. In four of Purple's cases, a bruit was heard, like blood passing from an artery into a vein; in a fifth case, a peculiar interrupted metallic tinkling was heard over the heart. This last sound, from blood and air together in the pericardium, was heard in one of Rose's cases; in another, he heard a systolic whizzing sound at the apex; in another, a friction sound; in others, the disappearance of the area of cardiac dulness, the tympanitic note on

percussion, the loss of the heart-sounds, or a metallic ring in them, showed the presence of air in the pericardium. But in any one case, if the patient recovers, the absolute certainty of the diagnosis may be called in question. The weak tumultuous action of the heart, noted in the American case, is also mentioned by Purple, who says that in the period of reaction palpitations not unfrequently arise, with a peculiar trembling of the organ, with irregular pulse.

He gives two cases, where there seems no doubt that the heart was wounded :—

1. A young man, aged 19, was stabbed with a knife between the fourth and fifth left ribs over the heart. Five minutes later, he vomited : the jaws were somewhat rigid, the face covered with sweat, the eyes sunken, the respiration irregular, interrupted, and sighing : no action of the heart could be made out ; venous blood was flowing in a continuous stream from the wound : not less than a gallon (?) of blood was lost. He was laid on his back, wet towels were put to his chest, etc., and the hæmorrhage stopped ; reaction set in four hours later, and he nearly died ; but with morphia, careful nursing, and absolute rest (the catheter was used on every occasion for sixteen days) he recovered. 'For about two weeks there existed a distinct bellows-sound in the heart.'

2. A man was stabbed with a knife over the heart. 'On examination after dilatation of the wound, the lung and pericardium were found to be wounded, and there existed a superficial laceration of the apex of the heart, half-an-inch long. It could be perceived by the finger how, by the systolic action, the heart lengthened, and touched with its somewhat outward-bowed apex the sixth rib, and by the diastole it shortened itself. The movements of the heart appeared to resemble the screw-like movements of a spiral spring.' The treatment was free venesection, rest, low diet, etc. He made a good recovery.

I add Rose's tabular statement of his own cases : his essay is of the greatest value, and should be carefully studied.

ROSE'S CASES (

(a) WITH

No.	OTHER INJURIES.	SIGNS AND CONSEQUENCES OF THE HEART.
1	——	Severe hæmorrhage; inter Partial pneumo-pericardiun tic note. Metallic splash synchronous with heart ring of heart wounds). Pe
2	Lacerations of kidney and cæcum.	Total pneumo-pericardium. dull area and of heart sour tic pericarditis.
3	——	Pulse irregular. Heart-sou Systolic whizzing sound he Pericarditis: later, a cardi

(b) WITHO

4	——	Attack of asphyxia through c of heart by effused blood.

SHOT WOUNDS OF THE HE

(a) WITHOUT

5	——	Hæmo-pericardium.
6	——	Friction sound, later pericard recovery, there was left a the mitral valve.

(b) WITH

7	——	Severe hæmorrhage after the probe. Penetrating wou heart, healed before death Plastic pericarditis.
8	——	Severe hæmorrhage. Pneu dium (Tympanitic note, wi ring of the heart sounds) pericardium.

NOUNDS OF THE HEART.

LUNG—3 CASES.

SIGNS AND CONSEQUENCES OF THE WOUND OF THE LUNG.	COMPLICATIONS.	RESULT.
Surgical emphysema. Parenchymatous hæmorrhage. Pleurisy with effusion.	——	Recovery.
Exit of air from the wound. Pneumothorax and pneumo-pericardium.	Repeated attempts to tear off bandages. Tuberculous cavities in both lungs.	Death.
Hæmothorax.	——	Recovery.

OF LUNG—1 CASE.

——	——	Recovery.

ALL, THE LUNG WAS ALSO INJURED.

—2 CASES.

Hæmothorax.	Two bullets in the lung.	Death.
Hæmoptysis; surgical emphysema; pleurisy with effusion.	Delirium tremens. Bullet healed over in the lung.	Recovery.

—2 CASES.

Hæmoptysis. Later, consolidation of the lung.	Repeated attempts to tear off bandages, &c. Two bullets in the lung.	Death 13th day.
Dyspnœa; surgical emphysema; pneumothorax; pleurisy with effusion.	Removal of the bullet from the lung.	Recovery.

Needle-Wounds of the Heart.

So many cases of this kind are recorded, and they differ in so many ways from knife wounds and gunshot wounds, that they require separate consideration. They have a distinct character of their own, and give a good hope of recovery, and afford an excellent opportunity for good surgery, and for operation. In some cases, a needle or a knitting-needle enters the heart by accident; in others, it is inserted for self-destruction, especially by those who are insane; in others, it makes its way into the heart from some other part of the body. Or it may be found *post mortem* in the heart, with nothing to show how it got there. Many of these cases afford only curious reading: others [1] have a practical value and concern us here.

1. A girl, aged 18, leaning over her needlework, ran a needle into the *right* side of her chest, near the breast; but she was not sure whether it remained in or not. This happened on the 2nd of August. On the 3rd of September, without premonitory shivering, or cough, or dyspnœa, she had an attack of pleurisy on that side, which soon yielded to treatment. On February 13th of next year, she showed signs of a slight pneumonia of the same side, with some general bronchitis: these left a troublesome cough. On March 10th, there was noted spasmodic action of the diaphragm. March 26th, obstinate vomiting. April 5th, signs of pericarditis; weak irregular pulse. Rapid loss of strength: death on April 27th, nearly nine months after the accident. *Post mortem*, right lung adherent to pleura, hepatization of the bases of both lungs. Pericardial adhesions: more than a pint of fluid blood in the pericardium. The needle had passed through the right ventricle, then through the septum ventriculorum: its point projected into the left ventricle, its eye being embedded in the wall of the right ventricle.

[1] Fischer, Purple, and Stelzner, *loc. cit.*; Callender, "Med. Chir. Soc. Trans.," lvi., p. 203. See also the discussion on Stelzner's case, the last of those here quoted: and Ziemssen "Ueber Nadeln im Herzen." Inaug. Diss. München, 1884.

2. A man, wishing to kill himself, thrust a darning-needle into his heart through the fifth left intercostal space. The mark of the puncture in the skin was just visible. An incision was made, which opened the pleura. The needle was seen to be fixed in the heart, and was withdrawn, followed by a forcible stream of blood. The patient died of 'pleurisy' a week later. *Post mortem*, the left ventricle was found perforated, and there was a small abscess in its wall.

3. A young lady, in a fit of melancholy, drove a needle into her heart through the sixth intercostal space: no sign of any serious injury was observed. Next day, the eye of the needle could just be felt under the skin, and there was slight pain on pressure here. Nothing was done till the fourth day, when a small incision was made, and the needle easily removed. It was two inches long, and pointed straight into the heart: it was slightly rusted on the surface.

4. A man, aged 31, after a struggle with another man, missed a needle two inches long which had been stuck in his coat, and felt sure it had entered his chest. Next day, he felt some pain about the heart, and came to Hospital; but nothing could be seen or felt. He kept at work for nine days, but his pain continued and became worse, and he complained of palpitation of the heart, and of continuous pain from the nipple to the axilla, and down the inner aspect of the arm to the elbow. In the fifth space, one could now feel a slight ill-defined fulness, as though with each impulse of the heart something firmer than the tissues came against the finger; the heart-sounds were natural, the impulse was not excessive. Incision under chloroform exposed the eye of the needle, moving a little forward and to the right with each beat of the heart; it was withdrawn straight out, without any change occurring in the regular action of the heart; there was slight bleeding, which stopped on pressure. He was kept in bed for four weeks: he complained of a sharp pain when he first got about, but this did not last.

5. A girl, aged 11, ran a knitting-needle into her chest, in the region of the heart, and it broke off short; she fainted, but soon revived, and was put to bed; the puncture was just visible. She soon became restless, complaining of severe pain and difficulty of breathing, and was brought to Hospital; the needle could be felt beneath the mark of puncture, in the third space. An incision was at once made here by the house surgeon, and the needle was seized: but at each attempt to withdraw it, the heart was drawn forward with it, and the needle did not come out. He sent for the surgeon,

who withdrew it, very slowly, a little way at a time. No severe bleeding followed. It was noted that she had a loud systolic murmur just before the needle was removed. As it was withdrawn, the murmur grew gradually fainter, and ceased the moment it was out. At first, the needle moved up and down in a vertical line; as it was partly withdrawn, it swung up and down like a pendulum. On removal of the needle, the pulse dropped from 120 to 90, then slowly returned to 120, with respiration 50 to 60, and temperature 104. She made a good recovery.

6. A man, aged 24, to kill himself, drove a needle into his heart. He immediately suffered great distress and oppression; but the needle could not be felt, nor were any abnormal sounds heard in the heart. Next day his general condition was better: there was now a loud systolic murmur at the apex, and the pulse was irregular; there was a red spot at the lower border of the fifth rib, $1\frac{1}{8}$ of an inch inside the nipple line; a loud friction-sound over the apex; cardiac dulness not increased; pulse small, 92; temp. 100·7; no abnormal sounds in the lungs; respiration shallow, rapid, painful; the needle could not be felt. Next day, sudden great oppression, duskiness, small intermittent pulse, shallow breathing, marked prostration; loud friction sound over the heart, both in systole and diastole. *Operation:* a semicircular flap of skin and muscle was raised, but still the needle could not be felt: an inch of the fifth rib and its cartilage was therefore resected. 'I now found myself in the pleural cavity, and saw the lower edge of the lung; but nothing was to be seen of the needle. I packed the wound in the pleura with iodoform gauze, and opened the pericardium in its long axis, letting out 2 or 3 drachms of turbid fluid. As the pericardium was still stretched tight over the heart, I made my incision in it V-shaped, and could now see the heart, and with my finger plainly felt the needle in the wall of the right ventricle, just beneath its surface. At this moment, the patient struggled for breath, and the plug of gauze suddenly vanished into the pleura, and could not be found again. I now attempted, taking the heart by its apex between my finger and thumb, to push out the needle from behind forward, having my finger behind the heart. I succeeded in getting the eye of the needle exposed, steadied it with my finger-nail, and tried to get hold of it with the forceps; but the heart beat so hard that the needle slipped back and vanished into the interior of the ventricle, and lay upright inside it. Nothing more could be

done; I plugged my wound, and put in a few stitches.' For the next few days the patient steadily improved: pulse regular, murmur hardly audible after the third day; temperature once rose to 102°, but was normal after the ninth day. Six days after the operation, careful examination gave signs of left pneumothorax; the plug in the wound was removed on the eighth day; the heart lay exposed at the bottom of the wound, and was again examined, but nothing was felt of the needle: the wound in the pleura was healed. A few days later, there were signs of left pleural effusion, which extended to the middle of the scapula; but this became absorbed: he left the Hospital four weeks after the operation, in perfect health, with no signs of trouble either in heart or lungs.

These cases, especially the last three, show vividly the signs of a needle impacted in the heart, the necessity of operation, and the risks attending it. That the hearts of animals may be freely handled and subjected to long-continued treatment was clearly shown by Roy's celebrated experiments, published in the Royal Society's Transactions for 1892.

The mark in the skin may be almost invisible, and a strong magnifying glass should be used to find it. The Röntgen rays might give the exact position of the needle. The skin incision must be free; the needle must be drawn out slowly, a little at a time. It is true that needles, and even bullets, may become encapsuled and inactive in the heart;[1] but this is not likely to happen.

A case quoted by Riedinger illustrates the need of operation in these cases:—

A young girl ran a needle into her left breast, near the heart: the injury was followed by severe pain and fever. At the lower part of the breast there came a swelling, which pulsated in time with the heart. Eighteen days after the injury, she became collapsed, and died. The swelling was found to be a large collection of dark-brown purulent fluid,

[1] For the whole subject, see Salzer's monograph "On the Healing-in of Foreign Bodies," Syd. Soc. Transl., 1894, vol. 148.

communicating through the sixth intercostal space with the pericardium. In the pericardium was more than a pound of similar fluid, and the needle. The bleeding had come from the pericardium, the heart itself was not injured.

Among the curiosities of surgery, we have to note a few cases where a foreign body has in its wanderings reached the heart. In the body of a child a year old, who died three hours after a convulsive attack with dyspnœa, a needle was found lodged in the right bronchus, with its point in the cavity of the right auricle; the pericardium was everywhere adherent; the needle had been missed a month ago. A man, after three days' illness, was brought to Hospital suffering great distress and oppression, and died in a few hours. *Post mortem*, the pericardium was stained a blackish tint, and contained some old blood. In the wall of the right ventricle an ivory toothpick was sticking. 'Beside the main track, there were three other punctures in the ventricular cavity, as if the ventricle, in contracting, had come against the point of the foreign body, which had thus dug into its inner wall more than once.' And there are three very strange cases, too long to quote here, which seem to show, as Castelnau and Ducrest showed by experiment, that a foreign body may enter a vein, and so be carried by the blood-stream into the right side of the heart.

Prognosis in Wounds of the Heart.

In those rare cases that recover, healing takes place by the sealing of the wound with blood-clot, and by the formation of adhesions. A well-formed fibrinous plug was already present in a case where death occurred on the third day; in another case, of death on the fifth day, there was already a firm scar; in another, that died on the fifth day, there was a layer of fairly strong clot be-

tween the heart and the pericardium, about the size of a florin, and of considerable depth, giving a rough look like goose-skin to the surface of the heart. In a case of death sixteen hours after injury, the wound in the pericardium was already adherent to the diaphragm. Healing is favoured by the complex arrangement of the layers of the heart-wall; and it is probable that the heart bleeds only in diastole, not in systole.

There are many secondary and ultimate troubles that may follow a wound of the heart not of itself fatal. Suppuration in the pericardium, in the mediastinum, or in the pleura; secondary hæmorrhage; a fistulous track outward from the heart; hypertrophy, dilatation, aneurysm, or ultimate softening and rupture of the heart; dense pericardial adhesions. In several cases, cerebral embolism has taken place. A man,[1] aged 52, stabbed himself in the fifth left intercostal space, just inside the nipple line, and was at once admitted to Hospital, conscious, able to speak, frightfully pale; the pulse could not be felt, the heart-sounds could hardly be heard; there was some emphysema over the left side of the chest, no marked dyspnœa, no hæmoptysis; marked increase of dulness over the heart, but mostly toward the left (hæmothorax). That evening, he suddenly lost consciousness; next morning, he was conscious, but there were now paralysis of the right arm, weakness of the right leg, and weakness of the right facial and hypoglossal nerves. Two days later, these were much less marked;

[1] For this case, and references to many others, and for a long discussion as to the symptoms and physical signs of a wound of the heart, see Karplus, "Ein Fall von Penetrirender Herzwunde mit Embolie des Gehirns." Wien. Klin. Wochenschr., 1891, p. 609. In one of Rose's cases, an injury of the heart was followed, on the fifth day, by gangrene of both feet; the patient recovered after double amputation above the knees.

they slowly disappeared; the blood in the pleura was partly drawn off, partly absorbed; and the patient made a good recovery.

Treatment.

Such of these troubles as offer any hope of surgical treatment are mentioned elsewhere; at present, we need only consider the immediate consequences of the wound. The need of absolute and perfect rest of body and mind, and of low diet, are of course understood: morphia may in some cases be of great benefit. To these measures, we must add venesection, for some cases, where the patient is restless, excited, and heavily oppressed, and the external hæmorrhage is not profuse. This restlessness and oppression may be due to the accumulation of blood within the pericardium; and the patient cannot hold out against the blood setting rapidly round the heart, and stopping it; fatal compression of the heart, 'herztamponade.' This is the cause of death in wounds of the heart that are at once fatal; but if the wound is small the blood accumulates slowly. The following two examples[1] of compression of the heart illustrate the mode of death from it, and the need for interference, if there is a chance of it.

1. 'I was called at two in the morning (December, 1875) to come quickly to a restaurant in the town. I found a young physician, one of my own pupils, gasping for breath, speechless, livid, lying on a bed there; his pulse could not be felt, but he was fully conscious. Over the upper part of the heart was a knife-wound, about an inch long, which neither bled nor gaped. The whole picture of compression of the heart was presented to me; and in fact, the area of dulness showed that the pericardium was so distended as I have never seen it during life. . . . . It looked as though the patient's death would occur in a few minutes. I at once

[1] Rose, *loc. cit.* p. 345.

bled him freely; and as the blood flowed, the pulse began to come back, and the sense of suffocation grew less. The more the blood flowed from his vein, the stronger grew his pulse; and I think I must have let over two pounds of blood.' The patient was kept in Hospital for five weeks, under very strict rules of diet and nursing; the hæmorrhage was absorbed, and he made a complete recovery.

2. A man, about middle age, died unexpectedly and suddenly, and an inquest was held. At the *post mortem* examination, the pericardium was found distended with blood, and a needle was found in the wall of the heart, projecting into the right ventricle; there was some softening of the wall round it. The mark of puncture of the skin was just visible; the needle had been driven into his chest by accident, three days before death.

It is this compression of the heart, that we have to remember above all else in surgery of the heart. To diagnose it, we must take every aspect of the case together: the general state of the patient from hour to hour, the evidence of auscultation and percussion, and all else that we can possibly learn or estimate. And if all these evidences together point to a steady accumulation of blood on the heart, and if neither rest, nor venesection, have succeeded in stopping it, then our only hope is in tapping the pericardium or making a small incision into it.

I have endeavoured in this chapter to put as clearly as possible the hopes and fears that attend the treatment of a wound of the heart. Happily, these cases are rare: a needle-wound is likely to do well after operation: a knife-wound or bullet-wound gives little room for hope, but, if it be not at once fatal, the surgeon may be able even here to avert death. Some further notes on wounds of the heart are given in the chapter on 'Pericardial Effusions.'

NOTE.—Capellen has just published a case where he sutured a wound of the heart: see chapter on Pericardial Effusions.

CHAPTER XI.

WOUNDS OF THE DIAPHRAGM. DIAPHRAGMATIC HERNIA.

THE position and action of the diaphragm make it, from a surgical point of view, one of the most interesting structures in the body. We have to deal with a strong curved muscle, of very great size, attached all round the chest, deep within it, never at rest, working between huge serous cavities, able either to stop or to spread infection, and in immediate relation with vital organs. From its constant movement, it fails to heal when it has been wounded, or the scar is weak, and may break down years afterward. From its relation to the viscera, a wound of it may be followed by strange unexpected results, either early or late. Finally, it has only of recent years come within the province of operative surgery. In the literature of the surgery of the diaphragm, every page is worth reading, and I would especially commend, for pleasant and profitable study, the essays of Lacher,[1] Frey,[2] Rydygier,[3] and Severeano.[4]

OPEN WOUNDS OF THE DIAPHRAGM. VISIBLE DIAPHRAGMATIC HERNIA.

Of wounds of the diaphragm, apart from diaphrag-

[1] Ueber Zwerchfellshernien, "Arch. f. Klin. Med." 1880, xxvii., p. 268.

[2] Zur Casuistik der Zwerchfellsverletzungen, "Wien. Med. Wochenschr," 1893, p. 160.

[3] Zur Operativen Behandlungen der Zwerchfellsverletzungen "Wien. Klin. Wochenschr," 1892, p. 713.

[4] Considérations sur les Plaies du Diaphragme par la voie thoracique, Congrès Français de Chir., 1893.

matic hernia, we know very little: they are either accompanied by other injuries, or are suspected rather than proved. It is worth noting that hæmorrhage, after injury of the chest, may possibly come from the diaphragm, not from the lung; but I know of no case where this has been discovered by operation. An incised wound rarely exposes the diaphragm to sight or to treatment. Still, this may occur without hernia; or the hernia itself may be not deep within the thorax, but close under the wound. The following cases[1] illustrate this kind of wound and this kind of hernia, and are moreover excellent lessons in surgery.

1. A soldier, aged 21, received a severe sword-wound, more than nine inches long, in the 8th right intercostal space, laying open the pleura; at each inspiration, the lower edge of the lung protruded at the posterior angle of the wound. The diaphragm, with a wound four inches long in it, was exposed in the anterior part of the wound. The surgeon, not being able to get at the upper edge of the wound in the diaphragm, sutured the lower edge of it to the lower border of the 8th rib, and thus shut off the pleural cavity, to the great relief of the dyspnœa. The huge external wound was packed with gauze for four days, and then sutured. For a week, there was some dulness over the base of the lung. He made a complete recovery.

2. An old soldier, aged 50, in 1882 received a sword-wound in the 8th left intercostal space, between the axillary and nipple lines. The wound was sutured; forty-eight days later, he noticed a small swelling under the scar when he coughed. A year later it was the size of a hen's egg. In 1893 it was still no larger; it was painful, sometimes dull, sometimes resonant, sometimes gurgling; he had pain in it, pains in the chest, dry cough, impeded respiration; dulness and friction-sounds over the base of the lung. *Operation.* A large elliptical incision was made, beginning at the 4th rib, an inch from the sternum, passing down, below the swelling, to the 11th rib, then passing up, in the axillary line, to the level at which it started. The flap of skin and muscle was raised, the 7th, 8th, and 9th ribs were divided

[1] Frey, *loc. cit.* Llobet, "Revue de Chirurgie," March 10, 1895.

in two places on either side of the swelling, and raised in a separate flap of bones, intercostal muscles, and pleura, and the intercostal arteries were secured. Three or four ounces of sero-fibrinous fluid escaped from the pleura. It was impossible to prevent collapse of the lung by drawing it forward with the forceps, as the pleural cavity was blocked with false membranes; air rushed into the cavity, the lung collapsed to a mere stump packed away against the spine. The swelling was found to consist of colon and omentum, contained in a sac. The sac and the omentum were cut away; the peritoneum was sutured, then the diaphragm; the deep flap was replaced, and a couple of silver sutures put through the 9th rib; the ring in the intercostal space was closed with a catgut suture; the huge musculo-cutaneous flap was replaced, muscles and skin being separately sutured; the air in the pleura was sucked out with an aspirator, and the chest was dressed and lightly bandaged.[1]

Beside the skill and success of the operation in this case, we have to note the idea of drawing forward the lung; the aspiration of the air that entered the pleura during the operation; and the copious effusion of blood-stained serum that followed the operation.

General Characters of Diaphragmatic Hernia.

Leaving these exceptional cases, we come to the ordinary examples of diaphragmatic hernia, internal, deep within the thorax; due either to a congenital gap in the diaphragm, to rupture by indirect violence, or to direct wound.

In Lacher's tables of 276 cases of diaphragmatic

[1] There was a good deal of depression after the operation; pulse small, rapid, and irregular; temp. 95°; a little dyspnœa, resp. 36. The day after it, the lung reached to the lower angle of the scapula, and in a few days it was fully expanded. A week after operation, he complained of severe pain about the 8th intercostal space in the axillary line, and fluctuation could be felt here; the lips of the wound were therefore separated at this point, and half-a-pint of sero-sanguinolent fluid was let out of the pleural cavity; a double drainage tube was put in for two days. He made a perfect recovery.

hernia (excluding one or two doubtful cases), 117 were of congenital origin, and 150 were due to injury. In both kinds, the hernia is usually on the left side; in the 117 cases of congenital origin, 98 were left, and 19 right; in the 150 cases due to injury, 127 were left, and 23 right. As regards this left-sidedness of congenital gaps in the diaphragm, we may note that hare-lip also is more often on the left side, and so are certain new growths, of mixed embryonic structure, in the palate and the parotid region.[1] The left-sidedness of diaphragmatic hernia after gunshot or knife wounds is due to the support given to the right side of the diaphragm by the liver, and to the fact that the wound is inflicted, whether for suicide or murder, by the right hand, aiming at the heart. The same rule applies to rupture of the diaphragm by general contusion or crushing of the chest; such injuries are about five times commoner on the left side than on the right; there is less support from the liver, and the natural openings through the diaphragm are more toward the left half of it.

The opening in the diaphragm is usually in the posterior part, and usually through its tendinous portion; and several cases have been recorded where the hernia has been due to dilatation of one of the natural openings in the diaphragm. In size and shape, it varies from a small slit or round or oval hole to a congenital loss of one-half, and in one case the whole, of the diaphragm. In congenital cases, other deformities are sometimes present, in the fingers and toes, the iris, and elsewhere. Only in a few are the displaced viscera contained in a sac: in 28 out of the 276, there was a sac; 25 of these were congenital. Adhesion of the

[1] I may refer to a paper of mine on this subject in "St. Bart. Hosp. Reports," 1886.

viscera to one another, or to the diaphragm, have seldom been noted; certainly one should not, by fear of them, be debarred from operation.

Regarding the organs displaced, in only 53 cases was a single organ involved; in most, two or three were displaced together. In 151 cases, the stomach was involved; in 145, the colon; in 83, the small intestine; in 45, the liver; in 35, the duodenum; in 27, the pancreas; in 20, the cæcum; in 2, the kidney.

The causes of diaphragmatic hernia after an injury, in 102 cases, were as follows: in 35, stab on the left side; in 2, stab on the right; in 26, blow or contusion on the left side; in 9, the same on the right; in 13, shot on the left side; in 1, on the right. In 10, general concussion or crushing of the chest; in 6, simple increase of abdominal pressure (during labour, vomiting, etc.). In the last 6 cases, it is probable there was some predisposing cause. As we should expect from this list of injuries, it is five times more common among men than women.

Congenital hernia hardly concerns the surgeon: in almost every recorded instance it has been found on dissection of a fœtus or a still-born child.[1] Or the child may live a few hours, days, or months, as in the following cases[2]:—

1. A male child, well formed outwardly, born after an easy labour. 'Immediately after birth, it gave two or three short, sharp cries, and then, though it seemed to make every effort, it was unable to produce a sound. Respiration became gradually shorter and quicker, cyanosis deepened, and death occurred an hour later. *The only abnormality found was the position of the apex-beat, in the right axillary line.* Only a most superficial examination, however, was made, as all our

[1] A good account of it is given by Mr. Bland Sutton, "Med. Chir. Soc. Trans.," 1884.

[2] "Boston Med. and Surg. Journ.," Jan. 31, 1895. Lacher, *loc. cit.* See also Dr. Newton Pitt, "Path. Soc. Trans.," 1892, p. 79.

efforts were concentrated on encouraging him to breathe.' *Post mortem*, the greater part of the left half of the diaphragm was absent; the stomach, spleen, and most of the small intestine were in the thorax; the left lung was very small, and was pressed upward and forward. Both lungs were compressed, but could be distended.

2. A male child, one year old, always very feeble, subject to convulsive attacks, always cyanosed, died of 'heart disease.' During life the apex-beat was on the right side, and the case had been taken as one of 'ectopia cordis.' *Post mortem*, there was found a congenital gap in the muscular portion of the left half of the diaphragm, close to the spine; part of the colon, and the left kidney, lay in the chest, enclosed in a peritoneal sac; the heart was displaced far over to the right, and the lung badly compressed.

The lung, in those infants who are still-born or die soon after birth, may be a mere nodule of no possible use; and this, and the physiological defect of those infants who have grave anatomical deficiencies, may account for their inability to live. Some few children survive, and may even reach old age.

Diagnosis and Prognosis.

Cases are recorded where, all through life, the hernia gave no trouble; but, for the majority, life was made a burden by troubles which were supposed to be due to dyspepsia: pain, nausea, vomiting, dislike of food, heartburn, thirst, colic, constipation alternating with diarrhœa. In such cases, a diagnosis is almost impossible; but there may be something, in this or that case, to lead one toward it. In most of them, the pains and troubles were worse after exertion; in others, a heavy meal gave relief; in one or two, the patient was conscious after food, that it was not where it ought to be, or the surgeon could hear gurgling in the chest; in others, there was a fixed pain through the chest, and a painful spot in the hypochondrium. In one case,

the œsophagus was compressed, the patient was wholly unable to swallow, and soon died. If the hernia be very large, there may possibly be a hollowing of the upper part of the abdomen, with a fulness of the side of the chest.

The symptoms that immediately attend the *first onset* of a diaphragmatic hernia are especially dyspnœa, which is usually the most marked of all; pain, oppression, cough, præcordial pain, a feeling that something has given way, inability to lie on the sound side. And in a few cases, the shock and the compression of the lungs have caused death almost at once. If the hernia be strangulated, the whole aspect of the case is that of acute internal strangulation; and these cases may come to operation.

Starting afresh then, from a purely practical point of view, we have to note that, out of nearly 300 cases of diaphragmatic hernia of all kinds, a right diagnosis was made in 7 cases only. Three signs, above all others, may help toward it: hollowness in the abdomen with fulness in the chest; sounds of movement of stomach or intestines inside the chest; and displacement of the heart. And doubtless some of the cases diagnosed as 'ectopia cordis' are cases of congenital gap in the left half of the diaphragm.

Next, we note that of 33 cases of knife wound of the diaphragm, collected by Frey (1893), no less than 29, or 88 per cent., ended, sooner or later, in death. Of these 29, 5 died from penetrating wound of the stomach, with escape of its contents; 2 from secondary empyema; 1 from cause not stated. In 21, death was from strangulated diaphragmatic hernia; of these, in only 7 did the strangulation take place at once, or soon after the injury; in 14, it occurred months or years after apparent

complete recovery—in one case, twenty years afterward. Some of the fourteen had received warnings of danger, by the hernia giving them trouble from time to time; others were seized without warning. In some, the fatal strangulation was brought about by coughing, straining, or some similar effort; in others, it occurred suddenly, for no known reason.

Moreover, of the eight who died, not of strangulation but of other effects of the wound, seven had diaphragmatic hernia of the bowels or omentum; and of the four who alone completely recovered, three had diaphragmatic hernia of the bowels or omentum, and in one the wound was on the right side of the chest.

Treatment by Operation.

Now, if anyone will take these figures of Frey's, and arrange them for himself, he will see—even after he has discounted them by remembering that doubtless in many unrecorded cases of knife-wound the diaphragm is wounded, and no harm comes of it—that a wound of the diaphragm is a very serious affair, and that a diaphragmatic hernia after injury puts a man in daily danger of death. Years after, the wound having never healed, or the scar having slowly yielded, he may die of acute strangulation, or from ulceration or gangrene of the nipped bowel; he is in no less peril than a man going about with a large inguinal or femoral hernia through a small ring, without a truss. And I believe that it would risk few lives, and save many, if we carefully opened up and explored every wound which appeared to have gone through the left side of the diaphragm, and, if we found the diaphragm wounded, sutured it at once. If the stomach or the bowels are wounded, there is all the more need to interfere;

if they are not, we shall have all the more hope of success.[1]

In rupture of the diaphragm from general contusion or crushing of the chest, it is not likely that the state of the patient will permit any operation, even if an exact diagnosis is possible; yet if such an injury be followed by intractable vomiting, with other signs of internal strangulation, operation is necessary. In congenital defect of the diaphragm, though Rydygier suggests that operation may be possible, I cannot find that it has ever been performed; it is hardly possible that it should ever be done of set purpose.

We need not trouble ourselves with Nussbaum's suggestion that one should introduce the whole hand into the rectum, and attempt through its wall to reach and draw down the hernia; or with Nélaton's advice, that the patient should be kept standing, and nourished only by enemata; or with the ingenuous doctrines of yet older surgeons, that solid quicksilver, or great quantities of food, should be administered, in the hope of dragging the stomach and bowels back into place. We have only to consider what can be and has been accomplished by operation. And we may take as texts four cases,[2] two where nothing was done, one of primary operation, and one of secondary operation.

1. A man, aged 44, was stabbed in the 5th left intercostal space, between nipple and axilla, and was brought at once to the Hospital. He was excited, garrulous, with a quick full

[1] In Frey's 33 cases, all knife-wounds, the stomach or the bowels were wounded in 7 only; the weapon seems in most cases to have lost its force by the time it reached them, so that it thrust them away instead of cutting them. The chance of success from early interference is less in gunshot wounds than in knife-wounds.

[2] Lacher, Severeano, *loc. cit.* Dalton, "Journ. Amer. Med. Ass.," June 6th, 1891.

pulse; no collapse; no sign of pneumothorax or hæmothorax; pain darting through the left side, worse on deep inspiration; and *continuous copious vomiting*. The small wound gaped, and had bled pretty freely. It was carefully cleansed and dressed. Next day, he was restless, oppressed, feeble; his breathing was quick, shallow, and noisy; the heart-sounds could hardly be heard, and the apex-beat could not be felt. *The vomiting still continued.* That evening, he was seized with *severe abdominal pains*, made worse by gentle pressure; there were signs of acute peritonitis with effusion; he was still vomiting. Next day, he collapsed and died. *The vomiting lasted up to death. Post mortem*, commencing purulent peritonitis; in right pleura, half-a-pint of dark blood; in left pleura, half-a-pint of blood-stained purulent fluid; left lung somewhat collapsed, but not wounded. In the muscular portion of the left half of the diaphragm, a clean-cut wound an inch long; through this, three inches of the colon, and some omentum, just grazed by the knife, had passed into the pleural cavity.

2. A man, aged 27, stabbed himself over the heart, and recovered of his wound. *Three years later*, after four or five days of a feverish attack, with epigastric pain radiating through the abdominal cavity, he was admitted to Hospital. The scar of his old wound, an inch-and-a-half long, was in the 4th space, about an inch-and-a-half below the nipple. Two days after admission, he showed all the signs of *acute internal strangulation*, with high fever and delirium, distension, vomiting, collapse, agonizing pains in the epigastric and præcordial regions. Percussion, during a paroxysm of pain, gave a *distinctly tympanitic note* over the left side of the chest; the heart-sounds had a *distinct metallic ring*, and could be heard on both sides of the chest, and toward the left axilla. He sank and died early next morning. *Post mortem*, slight fulness of the præcordial region; in the left pleura were a large portion of the stomach, measuring 4 by 6 inches, and the duodenum, which had passed through an opening, an inch-and-a-half in diameter, with smooth edges, in the middle of the left half of the diaphragm. The hernia occupied three-fourths of the pleural cavity, compressing the lung and displacing the heart, and bore marks of strangulation.

3. A woman, aged 48, was stabbed in the 6th left intercostal space in the axillary line, and was at once admitted to Hospital: the wound was about two inches long; she had dyspnœa, as well as pain; there was some dulness at the level of the wound, and free bleeding; but the house

surgeon contented himself with a simple dressing.[1] The surgeon, next morning, examining the wound with his finger, found a great quantity of blood in the pleura, and the 6th rib was cut right through; proceeding to turn out the blood clot, he found a bit of cabbage-leaf in the wound, which he thought, at first, must have been applied to the wound and got sucked into the pleura; but, on resecting three inches of the 6th rib and opening up the wound, he found all the contents of the stomach, and part of its greater curvature, in the pleura. He resected three inches of the 7th rib, found the lung retracted and motionless, and sutured a wound in it, two-and-a-half inches long; he sutured a wound in the stomach, three inches long, with twenty-two sutures, cleansed the stomach, and replaced it in the abdomen, then sutured the wound in the diaphragm, two inches long; closed his external wound with deep and superficial sutures, and drained the pleural cavity with iodoform gauze. Unhappily, the patient did not rally, and died three hours after the operation.

4. A man, aged 26, had been stabbed, two-and-a-half years ago, in the 7th left intercostal space, two inches outside the nipple-line; he was admitted to Hospital and discharged as cured in a few days. His fatal illness began *five days before re-admission* with severe pain in the umbilical region, *complete obstruction* of the bowels, in spite of medicine, and *vomiting* during the first day, but not afterward. On admission, he was in a state of intense suffering; temp. 103°; abdomen hard and distended; pain constant, and made worse on pressure. The abdomen was opened in the middle line: there was acute peritonitis, and it was found that more than a foot of the colon, and the whole of the omentum, had passed into the left pleura. It was impossible to draw down the mass, till the opening in the diaphragm had been slightly enlarged by incision; it was then drawn down easily. The patient was much collapsed, and died four hours after the operation.

These four cases deserve careful study, and prove beyond all doubt the necessity of immediate operation. Let us then note what difficulties surround it, and how they may best be overcome. First, it is possible to fail

[1] "L'interne, à neuf heures du soir, se contentant de lui faire un pansement sans lui donner d'autres secours."

even to find the hernia by operation; this has happened in one or two cases. Next, the operation cases divide themselves into two sets; in one, the surgeon, guided by the wound, or by the scar of an old wound, operates through the pleura; in the other, having nothing to guide him, he opens the abdomen by the usual method for acute internal obstruction, and then finds he has to deal with a case of strangulated diaphragmatic hernia.

It seems clear that the best way to reach a diaphragmatic hernia is through the pleura, not through the abdomen. It is more easily, and more safely, reduced by gentle pressure from above than by dragging it down from below. If it is gangrenous, or wounded, or has fouled the pleural cavity, these disasters may be remedied, without infecting the peritoneal cavity. If the lung or the pericardium is also wounded, their wounds can be observed. If the external wound is recent, air may already be present in the pleura, and matters will not be made much worse by admitting more. And the free admission of air to the pleura, though it may for a time cause collapse of the lung, has this great advantage, that by altering the pressure within the pleura it makes the hernia easily reducible. Finally, it is much easier to close the hole in the diaphragm from above than from below.

For these reasons, the pleural operation is to be preferred; and the surgeon, guided by the recent wound, or by the scar of an old one, must expose the diaphragm freely, by resection of ribs, turning upward a large flap. In two cases, both successful, recorded by Postempski, the pleura was opened through the 7th space; in one, he reduced the bowel, in the other he sutured and reduced the stomach; in both, he closed the opening in the diaphragm. Different methods of resection, and of operation by flaps, have been described by different

surgeons; at all events we must make a free exposure of the diaphragm.

It is not likely, in any recent case, that the surgeon will find the hernia itself wounded; this happened in seven only of the 33 cases collected by Frey. In such an event, he must go on the lines given in case 3 just quoted. If it be gangrenous, he cannot, in all probability, either resect it from the pleural wound, or draw forward and fix it; and his last very faint hope of saving the patient's life must be in cleansing the gangrenous mass, reducing it back into the abdomen, and dealing with it through an abdominal incision.

In the other set of cases, the surgeon has opened the abdomen in the middle line for the relief of internal strangulation, and has then found a diaphragmatic hernia. The records of these cases show that in such a state of things the hope of success is not very good. In one, the surgeon, after enlarging the ring, was able to draw down the bowel: but it went on to gangrene, and the patient died nine days after the operation. In another, the surgeon could not get at the ring to enlarge it, but at last managed to slip his finger alongside the hernia, through the ring, and then was able to hook down the diaphragm with his finger, to enlarge the ring, and to reduce the bowel. In another, neither the enlarging of the ring, nor the pulling at the bowel, availed to reduce the hernia; the surgeon therefore made an incision through one of the intercostal spaces, and let some air into the pleura, and at once the hernia was easily reduced.

This opening of the pleura is advocated by Rydygier for other reasons, if the surgeon, having opened the abdomen, finds a diaphragmatic hernia. For thus he can ascertain the state of the strangulated bowel, and not drag at a coil of bowel already soft with gangrene; he

can ascertain the state of the pleura, and not enlarge a ring that opens into a septic pleural cavity; and he can more easily, having reduced the bowel, close the opening in the diaphragm.

But to add pneumothorax to abdominal section, in a case of acute internal strangulation, may take away the patient's last hope of recovery; and this method is only justified in the very worst cases, where reduction is otherwise impossible.

NOTE.—In writing this chapter, I overlooked the valuable case of diaphragmatic hernia recorded by Dr. Hale and Dr. Goodhart in the "Clinical Society's Transactions," for 1893. A gentleman, 49 years old, after much exposure and hard work in India, came home to England on account of ill-health. He complained chiefly of 'water-brash' and acid eructations, with occasional vomiting: no evidence was found of organic disease. He was constantly bringing up mouthfuls of dark-coloured mucus, while about every week or ten days he *vomited enormous quantities* of fluid of a similar character. He complained of *heat and pain at the ensiform cartilage. His bowels were obstinately confined.* With strict dieting (at first, milk and rusks: later, nothing but peptonized milk), the vomiting stopped for a whole month; then it came back as bad as ever, and the stomach was washed out daily for a fortnight with decided benefit; then a less restricted diet was tried, but *copious vomiting* of yeasty fœtid fluid at once followed. Emaciation now became rapid and extreme. Two days before death, *tympanitic resonance behind up to the angle of the scapula* was noted, and *retraction of the abdomen.* He was thought to be dying of cancer of the stomach. *Post mortem*, a diaphragmatic hernia was found containing the greater part of the stomach, which was enormously dilated, the pylorus, the duodenum, the greater part of the pancreas, a large loop of the transverse colon, and the lesser omentum. There was a distinct hernia sac occupying the posterior mediastinum, extending across the spine from the œsophageal opening in the diaphragm to the opening for the vena cava inferior.

PART II.—DISEASES OF THE CHEST.

CHAPTER XII.

CARIES AND NECROSIS OF RIBS AND STERNUM. INFLAMMATION OF THE ANTERIOR MEDIASTINUM.

THE ribs and sternum very rarely suffer acute inflammation, either that form of acute periostitis or osteo-myelitis which used to be called acute necrosis, or any inflammation analogous to the acute epiphysitis of children; but they are liable to chronic specific inflammations—syphilitic, typhoidal, and above all, tuberculous—not during childhood, but in adult life. Yet, if we consider the number of the ribs, and the mass of bone they represent, it is evident that they have some immunity from all forms of inflammation, which is probably due to their having so little cancellous tissue in proportion to their surface. In Billroth's and Menzel's table of 1196 fatal cases of caries, arranged according to the frequency with which the different bones were affected, the ribs occupy the sixth place. Their powers of repair are so great that simple fracture can hardly cause necrosis, and non-union after it is almost unknown. Gunshot fractures are sometimes followed by necrosis of the ribs or sternum; and for this reason, and for the greater safety of the pleura, intercostal vessels, and lung, a splintered, comminuted gunshot fracture should be at once treated by removal of the fragments, and of any spicule or shattered end of bone, care being taken to avoid making

or extending a wound in the pleura. Necrosis has been known to follow resection of rib in the operation for empyema, but this does not often happen, or it may follow the prolonged use of a hard drainage-tube after simple incision of the chest.

Syphilitic Caries.

Syphilitic inflammation of the ribs or sternum is not common, though some cases have doubtless been assigned to tuberculous disease which were really syphilitic. It may occur either as a periosteal node, or as late tertiary infiltration of the bone; it is rather periosteal than central; rather gummatous than caseous; often of considerable extent along the ribs; often multiple: hence it may be mistaken for malignant disease, as well as for tuberculosis, and has been at least in one instance treated by operation as for sarcoma. In every doubtful swelling of the ribs or sternum, a patient trial must be made of anti-syphilitic remedies, in large doses. A good example of syphilitic disease of the sternum is given by Schuller.[1] The patient, aged 23, strong and active, had for some months been subject to nodular swellings, at first hard, afterward softening, over his sternum. On admission to Hospital, he had over the manubrium sterni an irregular excavated sore with undermined edges, and the bone beneath it was at one point bare and soft; he had similar swellings over other bones. Under proper local and constitutional treatment the ulcer nearly healed; but it broke down again, bare bone was felt, and a number of sequestra were removed, two of which were of considerable size. The ulcer now healed, leaving a sinus. But the disease broke out elsewhere,

[1] "Deutsche Ztschr. f. Chir." 1878.

and at last amyloid disease supervened, and he left the Hospital as incurable.

Caries after Typhoid.

Typhoid fever is, in some cases, attended or followed by a specific periostitis, and the ribs are often selected for its attack. This typhoid periostitis has been described in England by Sir James Paget,[1] in America by Dr. Keen of Philadelphia, and Dr. Parsons of Baltimore;[2] and in France by Dr. Mercier;[3] and Mr. Lockwood[4] has found the typhoid bacillus, more than a year after the fever, in an abscess over the tibia, in a girl nineteen years of age: he gives references to Hintzer, Orloff and Werth, who also have found it in similar cases; other common micro-organisms of suppuration are present with it. Mr. Carless has given a full account of it in the "Practitioner," Jan., 1896. He who wishes to study this most interesting subject will find other cases recorded by Mr. Stanley in his work on Diseases of the Bones, by Sir William Savory and Sir Dyce Duckworth in the St. Bartholomew's Hospital Reports, and by Dr. Clarke in the Journal of the American Medical Association, April 1891.

Dr. Keen collected no less than 69 cases of disease of bone following a continued fever; of these, 37 were typhoid. In 10 cases, the bone disease occurred in the first fortnight of the fever; in 27, from three to six weeks after the onset; in 10, still later. The bone most often attacked is the tibia, on the inner aspect

---

[1] Clinical Lectures and Essays.

[2] Toner Lecture; Smithsonian Collection, vol. xv. Washington, 1878. "Annals of Surgery," Nov. 1895.

[3] Revue Mensuelle de Médecine et de Chirurgie, 1879, iii., p 21.

[4] Traumatic Infection, 1895, p. 41.

of its shaft. It is to be noted that the bones that suffer are those most exposed to injury or pressure. Dr. Meacham notes no less than nine cases of necrosis after typhoid in one year's work in the Holy Cross Hospital, Salt Lake City, Utah: two were of the femur, three of the sternum, and four of the ribs.[1]

The following case of caries of a costal cartilage after typhoid was under my care some years ago; it shows clearly the need of very thorough methods of operation in this disease.

A man, aged 40, had typhoid fever in the spring of 1891, followed by periostitis of both tibiæ, and of one of the lower left costal cartilages. Of the swellings on the tibiæ, one was absorbed without suppuration, the other healed after suppuration, without exfoliation. The swelling of the rib slowly suppurated and was incised, but did not heal. In December, 1892, there was a sinus, 3½ inches long, running downward and outward close to the costal cartilages. I cut down, and opened it at its lowest point, scraped away a little rough patch on the lower edge of one of the cartilages, and drained the sinus for a long time, but still it did not heal. In November, 1893, I laid open the whole sinus, and found a deep, thick-walled cavity, leading to a costal cartilage, cut right across by caries; I resected the carious parts of the cartilage, and the tissues round the sinus, and kept open the greater part of the cavity, but fresh sinuses formed round it; these had to be laid open a fortnight later, and at last the whole wound healed.

I have heard of a similar case, where, the first operation having failed, at the second a small patch of caries was found on the *inner* aspect of the rib: when this had been well scraped the sinus healed.

Tuberculous Caries.

Tuberculous disease is the most common cause of caries of the ribs or sternum. In childhood, these bones

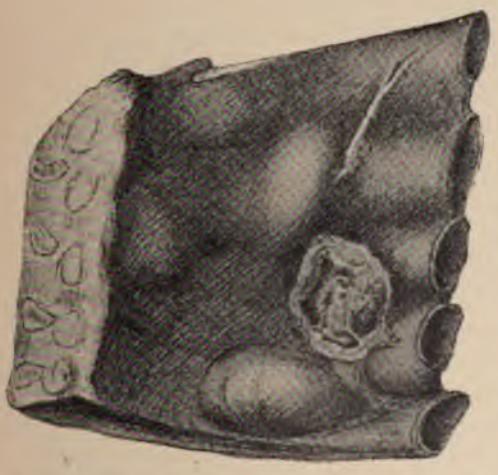
[1] "A Synopsis of Clinical Surgery," Salt Lake City, 1895.

rarely suffer; during many years' work at a children's Hospital, I remember seeing only one case of the kind—a little girl about six years old, with a small chronic abscess over one of the lower left ribs, about the axillary line; a few months later, she became affected with tuberculous disease of the spine. Mr. Watson Cheyne[1] points out that the disease begins more often in the periosteum than in the interior of the bone, and that the ribs most often affected are the fourth to the eighth, toward their middle portions. It may track far along a rib, may thin or even fracture it, may invade it at points far apart, may attack many ribs together; in one case[2] the clavicle, sternum, and first five ribs were diseased; in another, seventeen abscesses formed over the chest wall; in another, the chest wall was riddled with twenty fistulæ; in another, every rib in the body, as well as the spine, was affected. These severe cases are happily rare, and are rather proofs of the need of early operation than instances of the usual course of caries of the ribs. Plate III. is a good example of this multiple tuberculous osteo-myelitis.

The first symptoms are, as a rule, very slight, and a surgeon is not likely to see the case until a small swelling has already formed over the rib; even then it may be hard to diagnose it, if it lies beneath the breast, and has not yet begun to fluctuate. The surgeon must keep in view all three diseases—syphilis, typhoid, and tubercle—as possible causes of any swelling over the ribs or sternum. When the swelling has suppurated, it may be almost impossible to make a diagnosis between tuberculous caries and empyema. 'All the signs that are said to guide us in this matter—the outward shape of the chest, the expansion of some intercostal spaces and the

[1] "Tuberculous Disease of Bones and Joints," 1895.
[2] For References, see Riedinger *loc. cit.*

PLATE III.



Multiple Tuberculous Osteo-Myelitis of the Ribs: inner aspect. From Riedinger. (One of the abscesses has given way into the pleural cavity exposing a sequestrum.)

narrowing of others, the character of the pus, the irregular outline of the dull area, the recognition of healthy lung tissue below the level of the swelling, the fixed level of the pus, and so forth—are none of them sure signs one way or the other; the pus of a costal abscess may extend just as deep inward as the pus of an empyema[1].'

Taking the ribs, apart from the sternum, and putting aside those cases where the caries is secondary to disease near the rib, such as tuberculous empyema, we have to note several ways in which tuberculous caries may lead to great trouble. The pus may track or sink far and wide in the soft tissues, and may even appear in the loin, or in the front wall of the abdomen, or may enter the sheath of the psoas muscle, and point below Poupart's ligament. Happily, it very seldom breaks through the pleura, or into the lung; the pleura has almost unlimited power of protecting itself by thickening against invasion; in ten years' records at the Pathological Institute at Munich, only two cases of this kind are mentioned. But apart from these complications, the patient may die of extensive and persistent suppuration, of amyloid disease, or of tuberculous phthisis. Of four cases recorded by Settegast,[2]

[1] Messner, Ueber den Durchbruch kalter tuberculöser Abscesse der Thoraxwandung in die Lungen. "Verhandl. d. Deutch. Ges. f. Chir." Berlin, 1893, p. 128.

[2] "Langenbeck's Archiv." xxiii. p. 279. Similar cases are given by Billroth (Zurich, 1860-67); in one, a boy, aged 14, had a chronic abscess over the last two ribs on the right side; this was followed by the formation of other abscesses and fistulous tracks running upward. Operation showed that the cause of all the abscesses was the sixth rib, which was bare and rough. As the boy was young, and in fair general health, nothing more was done; the wound was healed in six months. In another case, a man, aged 29, for nearly a year had a chronic abscess over the third rib on the right side, near the nipple. There was spontaneous fracture of the sixth rib. As he was suffering with tuberculous phthisis, nothing was done.

one, a child aged 14, had caries of the elbow joint, the ankle-joint, and two ribs, and died of amyloid disease; *post mortem*, the sternum also was found diseased. Two had tuberculous phthisis, and one was a man past middle life, being 62 years old, who had previously had good health. In his case, the disease began with the 'typical hard infiltration' beneath the right breast: it broke down, and was incised and drained; erysipelas followed, and he recovered very slowly, and left the Hospital with fistulæ still unhealed. These four cases are dated 1873–76, and we get better results now; but they serve to show the dangers and uncertainty of the disease. Another danger, happily very rare, is hæmorrhage into the pleura from erosion of an intercostal artery.[1]

In the following cases, the abscess involved the pleura or the lung:

1. A woman, aged 25, complained in February of frequent catching pain in the right side of the chest, and in July was found to have a chronic abscess below the right scapula. In August this was incised, and in September there was found extensive caries of one of the ribs; one-and-a-half inches of it were resected; beneath it, there was a mass of caseous débris, the size of a pigeon's egg: this was cut or scraped away, and the wound healed, but a fistula remained. In February of next year, she had an attack of pleurisy with effusion, and about two quarts of serous fluid were let out. She left the Hospital with a small fistula.

2. A man, aged 41, who had for two years suffered from 'inflammation of the bowels,' had for the last three months been subject to pains in the left side of the chest, which were followed by an abscess over the posterior lower part of the chest-wall. On admission to Hospital, he was much wasted, the left side of the chest was somewhat flattened, and there was effusion in the left pleura, with œdema of the lower limbs, and slight distension of the abdomen. On March

[1] For this, and for the next three cases, see Fräntzel, Ziemssen's Handbuch iv. 2. 448; Hofmokl, "Klinische Zeit-und Streit-Fragen," Wien., iii. 173, and Messner, *loc. cit.*

1st, the abscess was opened, irrigated, and drained; the pus was very offensive and very abundant. In April, the abdomen had become distended with fluid, and on April 16th he died. The *post mortem* examination showed tuberculous peritonitis with ulceration of the small intestines. The lower border of the 11th rib, and the upper border of the 12th, were carious, and lay in a purulent cavity which communicated with the pleura by two separate openings. The pleura was adherent, and much thickened, and contained an abscess similar to the one round the ribs, communicating with it.

3. A woman, aged 42, was admitted to Hospital for a chronic abscess over the lower ribs on the right side, in the line of the scapula. Her general health was much impaired, and as bronchial breathing and crepitant râles were heard over the abscess, it seemed probable that it was not a case of simple tuberculous caries of the ribs, but that the pleura or the lung was already involved. Operation showed extensive caries of the 8th and 9th ribs, on their inner aspect; they were freely resected, pus was let out, and fungous granulations were cut away; there was then seen a narrow tract of granulation tissue running deep into the lung, just opposite where the 8th rib had been most diseased. The pleura here was much thickened, and the lung could not be seen through it; but except at this spot the pleura was healthy, and now that the granulations had been removed, the lung could be seen through it, moving up and down. The surgeon scraped the granulations from the narrow tract very carefully, and found a sinus, four inches long, running straight into the lung; he scraped its walls, and removed from its depths a small fragment of indurated lung tissue; about half-an-ounce of thin, curdy pus then flowed from the interior of the lung. A narrow drainage tube was passed down the sinus, and was kept in place for four weeks, as the discharge was somewhat copious. Ten days after the operation she coughed up some pus, and there were other signs that a bronchus had opened into the small cavity in the lung. The fistula healed in five weeks. After this, she had some caries of the manubrium sterni. She finally made a complete recovery. The tuberculous nature of the disease of the ribs was proved by the presence of tubercle-bacilli in the pus.

It is evident that any chronic abscess of the ribs must receive immediate and thorough treatment, and

that very careful search must be made for a patch of caries. The diseased rib may be some way off, or only one edge of it, or one side of it, may be carious. It is for these abscesses that Mr. Cheyne's method is to be followed. 'The skin and muscles are reflected from over the abscess wall, a T shaped incision being generally necessary; and, *without opening it*, the abscess is thoroughly isolated up to its point of attachment to the rib. It is then cut away, a strong stream of weak sublimate lotion playing over the part at the time, so as to wash away all the pus from the wound. The extent of the affected bone is then defined, the rib divided beyond it on each side, and the whole diseased part removed. There then remains a mass of tubercular tissue, corresponding with the deeper surface of the rib, which must be very thoroughly scraped away; the wound, having been well washed out, is now closed.' I have followed this method in two or three cases of chronic abscess, and have found great advantage from it.

One must not expect in all cases to find disease of the ribs; either the abscess began just external to the ribs, or the diseased spot has healed: but one is bound to search carefully for it, and to treat it then and there by thorough scraping or by resection of the rib on either side of the disease. Only by early and thorough methods of operation can we hope to obtain good results.

Caries of the Sternum. Mediastinal Abscess.

In the sternum, as in the ribs, caries due to syphilis or typhoid is very rare as compared with tuberculous caries; still, one or two instances have been recorded, and in any case the surgeon must keep all three diseases in mind. A case has also been published by Mr. Shield

of acute osteo-myelitis of this bone, ending in pyæmic abscesses in the lungs. As regards tuberculous caries of the sternum, the shape and structure of the bone, and the investment of its posterior surface by the tough resisting membrana sterni posterior, make it easy to understand that the disease may spread widely through the bone, before the pus finds its way outward through one of the intercostal spaces. The disease is likely to be far advanced before it comes under the care of the surgeon; if it involve only the anterior aspect of the bone, there may be a hard infiltrating tender swelling even at an early stage; but where the disease begins at the back of the bone, it can hardly be diagnosed at the time when diagnosis is most needed. Thus, the clinical records of caries of the sternum are mostly concerned with its later stages, and that most dangerous result of it, abscess in the loose cellular tissue of the anterior mediastinum. But there are other forms of inflammation of this region beside its invasion in caries of the ribs or sternum. It may be infected by an operation wound in the neck or axilla, or by direct injury. There is, moreover, a chronic form of inflammation, with formation of dense cicatricial tissue, often combined with adherent pericardium, the 'fibrinous mediastinitis' of Riedinger, or 'indurative mediastino-pericarditis.'[1] We are here concerned only with such inflammations of the mediastinum as may come within the field of surgery, including such as follow fracture or gunshot wound of or near the sternum, or may even come from severe contusion without fracture.

1. A young man was thrown heavily at football, and badly bruised. Some days later, he began to be feverish,

[1] See Dr. Thomas Harris' recent work on "Indurative Mediastino-Pericarditis," London, 1895.

restless, out of sorts, unable to sleep, and at last had to take to his bed. He complained of vague general pain in the chest, tenderness at the epigastrium, and pain after swallowing food, just as it reached his stomach; there was a pericardial friction sound, and crepitant râles over both bases. He was feverish at nights, pulse small and rapid. Some few days later his fever increased, and rigors occurred, and a few days after this, slight swelling, tension, and extreme tenderness were noted at the left border of the ensiform cartilage. At this point an aspirating trochar was put in, and slowly pushed onward so far that it received an impulse from the heart; a very large quantity of pus was drawn off. It was necessary, some days later, to repeat the operation; then the track of the needle was laid open, and the cavity was drained; it did not wholly close for six months; he finally made a complete recovery.[1]

2. A man aged 34, received a gunshot wound just above the middle of the sternum; the injury was followed by great pain, irregular action of the heart, and inability to lie down, but there was no proof that the bullet had perforated the sternum. Next day, there were swelling and pain about the wound, and his sputa were tinged with blood; suppuration followed, and became permanent, so that any over-exertion or exposure, even a year after the injury, would cause intense pain, swelling, dyspnœa, and a free discharge of pus, and he would be laid up for ten days or a fortnight. Finally, a sinus was left, and six years after the injury, with a sort of Nilaton's probe made of a fine thread of white clay lodged in a fine silver tube, the bullet was found lying two inches deep, behind a minute orifice in the sternum. With a trephine, two discs and a part of a third were removed from the sternum. The bullet was found encysted in a tough mass of dense fibrous tissue; the heart-beat was seen clearly beneath the thickened pericardium. The operation was followed by suppuration, absorption of pus, slight hæmoptysis, and slight pericarditis; and the wound did not heal for three months. He finally made a good recovery.[2]

The strong fibrous membrane investing the posterior surface of the sternum may serve to protect the loose areolar tissue of the mediastinum, even in gunshot fracture of the bone; out of 51 cases of this injury

[1] Wheelhouse, "Brit. Med. Journ.," 1887, ii. 1141.
[2] Marks, "Trans. Amer. Surg. Ass.," 1881-83, i. p. 308.

PLATE IV.

Caries and Necrosis of the Sternum, with perforation and formation of sequestra. (From a specimen in the Royal College of Surgeons' Museum.)

[Face p.

in the American War, only 18 ended in death, and Heyfelder has collected notes of seventeen operations on the sternum with only one death. Wonderful recoveries have been recorded; one man had his sternum comminuted by a three-ounce grapeshot, tearing open his left pleura; the ball lodged in the wound, and was removed by the patient himself; the arch of the aorta was exposed, the lung was collapsed, but he recovered, and regained in great part his former health.

As regards tuberculous caries of the sternum, the specimen, *Plate* IV., is a good example of advanced disease; it shows more than one perforation through the whole thickness of the bone, the formation of a sequestrum, the invasion of the articulated cartilages, the infiltration of the whole bone. On a bone so fragile as this it would be dangerous to press hard with a trephine; in more than one case, the trephine has broken the bone. 'The treatment must be conducted on the ordinary lines, abscesses being opened and washed out, bone being chiselled and gouged away, and so forth. In some cases, especially of posterior disease, it may be necessary to remove a portion of the sternum, generally the manubrium.'[1]

The surgeon is not likely to see the case till there is already an abscess. Nor will he always find bare bone, even in chronic abscess over the sternum. In such a case, a few weeks ago, I removed a large abscess over the left upper costal cartilages and left half of the sternum, following Mr. Cheyne's method, but not even the most careful examination enabled me to find any disease of bone or cartilage.

There remain for our consideration those difficult

---

[1] Watson Cheyne, *loc. cit.*

cases, where there is clear proof of injury or disease of the bone—perhaps a sinus, or an open wound, or a patch of caries—but it is the mediastinal inflammation, the pain, dyspnœa, feverishness, and oppression, that 'dominate the pathologic scene,' and there is no perforation through the bone. It is in such cases that the use of the trephine is necessary. The well-known paper on this subject by Mr. Ballance[1] gives full references to many cases of this kind, and his operation should be carefully studied. He laid open the fistulous tracks, exposed the surface of the sternum, and found it looking healthy, trephined it in two places, and cut away the intervening bridge of bone; let out the pus from the mediastinum, and carefully, with a Volckmann's spoon bent to a convenient shape, scraped the carious disease over the posterior aspect of the sternum, and lightly packed the wound. The patient's temperature after operation was never above normal, and she made an uninterrupted recovery.

At a meeting of the Société de Chirurgie, June 17th, 1895, M. Le Fort reported a case where he had removed the lower two-thirds of the sternum for advanced caries with multiple fistulæ. The operation presented no special difficulty: the bone was separated from the mediastinum by a very thick layer of fibrous tissue. M. Nicaise said that he had in three cases performed resection of part of the sternum for caries. In one of them he removed the upper end of the sternum, the sternal end of the left clavicle, and part of the two first costal cartilages: the parts beneath them were protected, as in M. Le Fort's case, by a thick layer of fibrous tissue. In another, he gouged the bone in many places, the disease being widely diffused through it.

[1] "A case in which the gladiolus was trephined for pus pent up in the anterior mediastinum." C. A. Ballance, "Med Soc. Trans.," 1889, xii. p. 8.

CHAPTER XIII.

TUMOURS OF THE RIBS AND STERNUM.

SECONDARY malignant disease of the bones of the chest-walls is so rare, and so far beyond the help of surgery—save for one or two isolated cases—that we need hardly consider it. The ribs and sternum may suffer in the swift universal invasion of melanotic cancer, or may be attacked in the spread of that strange form of cancer of the thyroid gland which has such a strong predilection for the bones—but, on the whole, the ribs and sternum are not often the seat of secondary malignant disease. The total amount of bone in them is enormous, but they are not favourable soil for secondary growths; even in cancer of the breast,[1] so near them, they often escape—it is rather the spine, or the upper part of the humerus, or of the femur, that is attacked.

And some forms of primary growth are so rare that they need only be mentioned. Lipoma, fibroma, simple osteoma: these have been recorded, and it is to be noted that a fibroma of the ribs may have processes closely adherent to the pleura. Madelung had a case of hydatid cyst of the sternum; but it remains one of the curiosities of pathology: out of 33 cases of hydatid of the bones, collected by Reczsy, not one was in the ribs or sternum. A nævoid growth over the ribs is common enough: in

[1] It is worth noting that primary cancer of an outlying lobule of the mammary gland may sometimes present itself as a small hard nodule, fixed firmly down on one of the ribs, at the very margin of the breast. I have had such a case, which had been diagnosed as 'periostitis of a costal cartilage.'

one case, it was mistaken, before the operation, for a lipoma; and during it, for hernia of the lung.

The great group of new growths with which alone we are now concerned is that of the enchondromata and sarcomata—tumours so mixed in structure that they are like the new growths of the parotid region. On the whole, those of the sternum approach the type of pure sarcoma—those of the ribs are more cartilaginous. Sarcoma of the sternum tends to be central rather than sub-periosteal; enchondroma of the ribs tends to occur toward their cartilaginous ends, and has often been noted after an injury. Sarcoma of the sternum has been mistaken for aneurysm, and aneurysm for it. And all these growths, as they increase, thin and destroy the pleura beneath them, and are likely to invade the mediastinum and the lung, or to form secondary deposits in them. From the point of view of operative surgery, it is impossible for the surgeon to tell beforehand what he will find; he may succeed in removing a very large growth without even wounding the pleura, or he may attack a small swelling over the ribs, and find a mass of growth behind them, and a large gap in the pleura; or he may believe he has to deal only with the chest-wall, and then come suddenly face to face with the dilemma, either to abandon the operation, or to remove a part of the lung or of the diaphragm.

1.[1] 'In 1861, a patient consulted me about a small, very painful, swelling at the level of the fourth intercostal space. It had been punctured, in the belief that it was fluid, but nothing had come from it. I made an exploratory incision, and to our astonishment we found that we had to deal with a solid tumour of the lung, adherent to the pleura, and not connected with the ribs. I drew it forward, shut off the pleural cavity with numerous points of suture all round it,

[1] Péan, "Congrès Français de Chirurgie," Paris, 1895, p. 77.

and removed it with the galvano-cautery; and, as the bleeding was troublesome, left some pairs of forceps on the bleeding points. She recovered, and was in good health the year after the operation.'

2.[1] A man, aged 24, in good general health, had a hard, rounded, flattened, shelving growth over the right ribs, from the fourth to the seventh, firmly united to them, and extending from near the sternum to near the anterior axillary line. He had noted it four years. The veins over it were dilated, the skin was not adherent, the axillary glands were not enlarged. There was no dulness of the mediastinum, no displacement of the heart; faint vesicular breathing was heard in the region of the growth, no râles, no friction-sounds. *Operation:* Nov. 8th, 1888: a large flap was raised, and it could then be made out that the intra-thoracic portion of the growth was much larger than the external swelling. Four inches of the fourth rib were removed, and then the fifth rib was similarly treated; at this moment, the pleura, which was very thin, was torn, and air was heard entering the chest. Part of the sixth rib was now resected, pleura and all, and the tumour was raised, exposing a gap in the pleura as big as a saucer. At this moment, the lung receded, and the growth went with it a little way back into the chest; immediately, the patient collapsed, his breathing stopped, his pulse could not be felt; injections of ether and camphor were given, and the danger passed off as soon as the growth was again grasped and drawn forward. It was now found to be firmly fixed, by a broad base, to the lower edge of the lung. The surgeon passed his finger over the lung, and felt no other growths in it; his assistant then held the edge of the lung forward, and kept it compressed, while he transfixed and tied it, cut away the growth with scissors, and closed the wound in the lung with a continuous suture. He then let go the lung: it collapsed at once; again the patient became deadly pale, and gave no sign of pulse or respiration; he seized the lung and drew it forward, and again the patient revived. When, on tying his last skin suture, the surgeon had finally to let go the lung, the patient once more collapsed; and for some days after, he had slight dyspnœa. Three days after the operation, six or seven ounces of serum were let out from the pleura. In March, 1891 (three and a half years later) a recurrent nodule, beneath the scar, was removed; a little air

[1] W. Müller, Ein Thorax-wand-Lungen Resection mit günstigem Verlauf. "Deutsch. Ztschr. f. Klin. Chir.," 1893, p. 41.

entered the pleura, but no harm came of it. In July, 1893, the patient was in perfect health. The growth was of a mixed character, mostly bone and cartilage at its centre, sarcoma at its exterior.

3. A man, aged 37, who had first noted the disease only four months earlier, had a very large tumour of the ribs (round-celled sarcoma) extending from the fifth rib on the right side down to the lower border of the thorax, and from the edge of the sternum to the lower angle of the scapula. *Operation*: the sixth and seventh ribs were resected from near the sternum backward for nearly their whole length; the pleura was torn, and, as the growth had begun to attack the diaphragm, a piece of the diaphragm was removed, about an inch and a half in diameter; through the hole thus made, the liver and the intestine protruded, and had to be put back: the diaphragm was sutured. The patient was badly collapsed, but revived under injections of ether, and faradization along the phrenic nerves. He died on the fourth day, of capillary bronchitis; the wound in the diaphragm was found firmly closed.

4. A man, aged 29, in good general health, had for ten years noted a growth on his right side, in front of the shoulder; it had of late increased rapidly, its lower part had become soft, and had been punctured, and fluid had been drawn off. It now extended from the second rib down to the nipple; passed forward an inch beyond the middle line, and backward to the posterior axillary line; it was nodular, hard as cartilage, fluctuating on its lower aspect, and almost as large as a child's head. *Operation*: April 26th, 1893: a large flap was raised, including part of the pectoral muscle, the third rib was cut through, and the growth was cleared with the finger, and raised: it was found

TUMOURS

Reference.	Sex and Age.	History and Symptoms.	Character of Tumo
1. Dudon, 1889	F. 28	Attributed to a blow: only noted a short time before operation.	Hard, slightly nodu size of hen's Enchondroma of manubrium.
2. Mazzoin, 1875	M. 55	———	Myxo-sarcoma.

more easy than had been expected to strip the pleura off it, except over its lower posterior aspect, where growth, pleura, and lung were all adherent together; at this point, a piece of the pleura, and a small piece of the lung, were removed with scissors. Little blood was lost; pulse and breathing remained good. The day after the operation, he had a good deal of dyspnœa; some suppuration occurred; he made a good recovery. The growth was cartilaginous, with cystic degeneration.

I give these four cases to show that the surgeon cannot be sure beforehand what he will find during the operation; the lung or the diaphragm may be involved, though the breath-sounds in the immediate neighbourhood of the growth appear perfectly normal, and though there be no marked sign of impeded respiration. Still, the study of a large number of cases gives us some help toward estimating the extent of the disease. The whole subject has lately been reviewed so thoroughly and carefully by Campe,[1] that I give, in a tabular form, some of the cases he has collected, and the rules of diagnosis he has deduced from them. To his collection of the records of other surgeons, he adds nine cases—three of tumour of the sternum, six of tumour of the ribs, that were under the care of König during the years 1882–93.

[1] Ueber Tumoren der Knöchernen Thoraxwand. Inaugural-Dissertation, Göttingen, 1894.

E STERNUM.

Operation.	Result.	Remarks.
st operation, removed with hisel. Recurred in four months; esection of sternum down to evel of third rib.	Recovery. Three small recurrent nodules removed later.	Neither pleura nor pericardium was opened.
esection of sternum, from manurium almost to ensiform cartiage, with pieces of the second, hird and fourth ribs.	Death 15th day from pneumonia and bronchitis.	———

TUMOURS

REFERENCE.	SEX AND AGE.	HISTORY AND SYMPTOMS.	CHARACTER OF T
3. Weinlechner 1882	F. 53	Since six years old, had noted a small hard nodule over middle of sternum. 3 years ago, a soft growth arose in connection with it.	Chondro-sarcom
4. Küster, 1883	M. 30	Painful swelling, right border of sternum	Diagnosed as sar
5. Pfeifer, 1884	M. 45	Noted nine months; rapid, later painful.	Size of an appl doughy consi Alveolar sarcom
6. König, 1882	F. 42	Two and a quarter years ago, began to have pain; first noted swelling a year ago. General health good, no troubles of respiration or circulation.	Tumour extende nearly the wb the sternum, little way int intercostal Osteo-sarcoma.
7. König, 1892	M. 59	History of injury three years ago. Growth first noted six months ago; rapid increase; difficulty of breathing lately on exertion, but only then. General health good.	Growth extends sternum from to fifth ribs; s man's fist, n somewhat ha defined; skin normal; no signs on ausc or percussion. chondro-sarcor

STERNUM—*Continued.*

Operation.	Result.	Remarks.
Hard nodule (enchondroma) removed level with sternum; soft growth (colloid sarcoma) extirpated.	Death 5th day from pyæmia.	———
Resection of right border of sternum, with pieces of third and fourth right ribs.	Recovery in four weeks.	Right pleura opened. Swelling was found to be a gumma.
Resection of sternum with pieces of second, third and fourth ribs on both sides.	Death a week after operation.	Right pleura opened. Hæmothorax, pleurisy, bronchitis, pneumonia; signs of tubercular disease of both lungs. Secondary growths in liver, kidneys, and 4th left rib; perforation of œsophagus.
Growth freely exposed; costal cartilages very carefully cleared and elevated, and divided in the following order: second left, second, third and fourth right. Manubrium now sawn across, remaining costal cartilages involved carefully divided, tumour found projecting into mediastinum, cleared with great difficulty. One nodule of the growth ran deep into the mediastinum, and it was uncertain whether it had been wholly removed.	Recovery. Some suppuration followed in the mediastinum, and gangrene of a small patch of skin. Operation lasted about three hours.	Patient died a year later of rheumatic fever. At the operation, both the pleura and the pericardium were opened; they were at once plugged with strips of gauze, which were withdrawn as the last stitches were tied. Left internal mammary artery was tied at operat'n.
Growth freely exposed by raising a large flap over it; ends of costal cartilages carefully cleared. Second right cartilage divided, then sternum sawn across just above it, then third to fifth right, and second to fifth left cartilages divided, then lower part of sternum sawn across. Considerable difficulty in clearing its posterior aspect. Both internal mammary arteries tied and divided at operation. Right lung adherent to growth at level of fourth rib; pleura opened here. Piece of lung removed with growth.	Death the day after the operation.	*Post mortem*, air and a considerable quantity of blood in right pleura. Dilated heart. Secondary growths in the liver.

TUMOURS OF

Reference.	Sex and Age.	History and Symptoms.	Character of Tumour.
1. Weinlechner 1880	M. 37	Noted four years; but after a blow grew very rapidly.	Size of man's head; growing from third to fifth right ribs; hard, but soft in places. Myxo-chondroma.
2. Mass, 1885	M. 42	Noted many years; attributed to a blow. Was at first small and painless; after a second injury, grew rapidly to enormous size, and became very painful.	Huge growth, 16 inches across, from left lower ribs; hard, elastic, very painful. Osteo-myxo-chondroma.
3. Baldus, 1887	M. —	——	Large growth, from second to fourth left ribs, from sternum to axilla, and from clavicle to nipple. Myxo-chondroma.
4. Halm, 1888	M. 33	Two previous operations during the earlier part of the year, with resection of rib.	Large recurrent growth, size of two fists, from lower ribs. Myxo-fibro-chondroma.
5. Riesenfeld, 1888	F. 22	Slow growth, no pain, no marked impairment of breathing.	From seventh intercostal space to ninth rib, on left side. Osteo-myxo-chondroma.
6. Marsh, 1890	F. 20	——	From third right rib; external swelling small, internal growth size of a man's fist.
7. Tietze, 1879	M. 46	Noted four weeks after a kick on the ribs from a horse. Three years slow growth, no pain.	Large, elastic, firm growth, 21 inches in circumference, arising from sixth to eighth ribs on right side. Giant-celled sarcoma.

THE RIBS.

Operation.	Result.	Remarks.
Resection of the ribs involved, with the pleura, and a piece of the lung 'the size of a saucer.' Removal of two small nodules from the upper lobe of the lung.	Death in 24 hours from purulent pleurisy.	———
Resection of four or five inches of ninth, tenth and eleventh ribs, with the pleura belonging to them.	Complete recovery in three weeks.	Dyspnœa for two days after operation; highest temp. 101·3°.
Resection of the ribs involved. Pleura opened.	Complete recovery in three weeks.	Pulse and respiration normal after the first 24 hours.
Resection of sixth to tenth ribs, wide opening made into the pleura; diaphragm wounded, and secured to upper edge of external wound; growth adherent to peritoneum; removal of a piece of the peritoneum 'the size of a saucer.'	Death soon after the operation.	———
Resection of eighth rib, and a piece of pleura two inches across.	Complete recovery in four weeks. No recurrence, five years later.	Though she had asthma, emphysema, and chronic bronchitis, the pneumothorax gave no serious trouble. Lung had fully expanded when she left the Hospital.
Resection of third rib, with piece of pleura three inches across.	Rapid recovery.	Lung did not collapse, but moved freely during operation.
Resection of large pieces of sixth to ninth ribs; diaphragm adherent, and wounded during operation.	Death two days after operation.	Marked dyspnœa after operation; death attributed to 'failure of the heart.'

TUMOURS

REFERENCE.	SEX AND AGE.	HISTORY AND SYMPTOMS.	CHARACTER OF T
8. Heigl, 1885	M. 10	No known cause; somewhat rapid growth, no pain.	Hard growth, fist, to left of s over second ribs. Fibro-s
9. Helferich, 1885	M. 27	Noted after an injury. Slow growth, two years' duration. At times, would become swollen and painful, then subside again.	Firm nodular size of fist, o to seventh right side. sarcoma.
10. Humbert, 1886	M. 21	First operation, a year ago; pleura was opened, and growth was merely cut off level with the ribs. Recurred in a few months; very painful; pleural effusion on affected side.	Recurrent grow of chestnut, seventh to nin Periosteal sar
11. Meyer, 1887	M. 31	Noted six months after an injury; rapid, painful.	Size of fist; celled sarcom not stated.
12. Krönlein, 1883–1888	F. 17	Tumour noted a year and a half before first operation. Recurred six months after first operation; again three years after second operation; finally, a year after third operation.	Sarcoma of sixt left side, siz child's head.
13. Tietze, 1889	F. 28	Noted nine years, came after a blow. Very slow growth at first, but much more rapid during each pregnancy. Painless at first, but finally very painful.	Hard growth, two fists, arisi fifth rib on le Nævoid oste ma.

RIBS—*Continued.*

OPERATION.	RESULT.	REMARKS.
Resection of second to fifth ribs, four inches each, and of a small part of edge of sternum.	Recovery in a fortnight.	Pleura and pericardium freely exposed, but not opened. Marked dyspnœa and rapid pulse after operation.
Resection of sixth rib. Pleura not opened.	Recovery.	———
Resection of seventh to ninth ribs. Pleura freely opened, sero-purulent fluid let out. Opening made into diaphragm, nearly three inches long.	Recovery in two months.	Recurrence soon after recovery; and operation this time ended in death.
Resection of ribs involved; pleura opened so wide that the whole hand could easily be introduced.	Rapid recovery.	Recurrence in six months; hernia of lung beneath the scar. Recurrent growth, and portion of lung, both removed; recovery.
1883. Resection of sixth rib; growth removed; pleura not opened. 1884. Resection of fifth to seventh ribs, very extensive; pleura opened, adherent piece of lung removed. 1887. Growth size of fist; resection of fifth rib, with adherent piece of lung.	Growth recurred in 1888, and no further operation was possible.	Died of pneumonia, Nov. 1890.
Resection of fifth rib; pleura freely opened.	Recovery.	———

TUMOURS OF THE

REFERENCE.	SEX AND AGE.	HISTORY AND SYMPTOMS.	CHARACTER OF TUMOUR.
14. Desguin,	M. 41	More than one operation had already been performed for primary or recurrent growths.	Spindle-celled sarcoma of the ninth right rib.
15. Witzel, 1890	M. 30	———	Sarcoma, size of fist, of tenth and eleventh ribs.
16. Plitt, 1890	M. 38	Noted soon after a very severe injury; painful; rapid.	Large growth, with secondary nodules round it, over sixth to ninth ribs; whole mass size of fist. Sarcoma.
17. Mikulicz, 1891	M. 54	Four years duration; never painful.	Huge growth, size of child's head, over lower ribs on left side; hard in some places, soft in others. Cystic myxo-chondro-sarcoma.
18. Caro, 1891	F. 31	Rapid growth, first noted three months before operation.	Soft, elastic growth size of fist, front of right side of chest, from clavicle to fourth rib. Periosteal sarcoma, growing from second rib.
19. König, 1882	F. 13	Growth noted, after rheumatic fever, a few weeks before operation; was thought to be abscess, and punctured. Very feeble general health.	Growth, about size of fist, left side, far back, over eighth to eleventh ribs. Dulness on percussion and loss of breath sounds for about a hand's breadth all round it. Heart not displaced. Round-celled myxo-sarcoma.

RIBS—*Continued.*

OPERATION.	RESULT.	REMARKS.
Resection of eighth and ninth ribs, with adherent pleura.	Recovery.	Pneumothorax disappeared within a week; but lung did not fully expand, and liver rose above normal level.
Resection of ribs involved, and of transverse processes of their two vertebræ, also diseased. Free opening into pleura. Severe dyspnœa, treated by converting the pneumothorax into hydrothorax, and then slowly aspirating the fluid.	Rapid recovery.	Before putting in the last stitches, he filled the pleura with warm boric lotion, thus expelling the air; then closed the wound, and slowly drew off the lotion through a catheter.
Resection of seventh to ninth ribs, six inches of each, with adherent pleura.	Recovery.	Only slight collapse of lung. Two subsequent successful operations for recurrence in glands.
Free resection of eighth to eleventh ribs; removal of a strip of diaphragm 3½ inches long by ¾ inch broad. Severe dyspnœa; hæmothorax, probably from wounded intercostal artery, treated by puncture.	Recovery.	Lung expanded well. Recurrent nodules removed from scar, nine months after operation.
Resection of three inches of second rib, with adherent infiltrated pleura. Next day, signs of hæmothorax; a few ounces of blood-stained fluid withdrawn.	Recovery in a fortnight.	No trouble from pneumothorax. Three subsequent operations next year for recurrent nodules, and death that year from recurrence past operation.
Operation showed extensive malignant disease, which was only scraped away so far as possible.	Rapid increase of disease, and death three weeks after operation.	*Post mortem*, signs of septic absorption. Mass of disease in pleural cavity, size of a man's head.

TUMOURS OF THE

REFERENCE.	SEX AND AGE.	HISTORY AND SYMPTOMS.	CHARACTER OF TUMOUR.
20. König, 1887	F. 26	Broke a rib a year and a half ago; noted swelling there a year ago. No pain, but tenderness.	Below right breast, over sixth to ninth ribs, a large flattened growth, giving marked feeling of fluctuation. Chondro-myxo-sarcoma.
21. König, 1891	M. 34	Noted only six weeks; not painful. Says he has a cough, and is losing flesh; looks thin, pale, feeble.	Firm, elastic growth, size of large apple, over seventh rib in anterior axillary line; no fluctuation. Alveolar round-celled sarcoma.
22. König, 1893	F. 30	Noted a year; slow growth, no pain.	Very hard growth, size of hen's egg, over sixth to eighth left costal cartilages, just where they join the sternum. Round-celled sarcoma.
23. König, 1893	M. 55	Noted six or seven years ago; gradual, painless; for the last year rapid, and painful on coughing.	Firm hard growth, but fluctuating over lower aspect; below right nipple, over fourth to seventh ribs. Cystic enchondroma.

I have left out a few of Campe's cases, which did not undergo operation, or are too briefly recorded to be of value, or happened long before we had learned to avoid the dangers of wound-infection, and of carbolic acid poisoning, which proved fatal to them. Among these older cases, the most famous is that of Richerand, who in 1818 operated successfully on a man aged 40, for tumour of the ribs (carcinoma), removing four inches of the seventh and eighth ribs, and eight square inches of the pleura.

Two cases of cancer of the ribs secondary to cancer of the breast, may be given here. Schede, after operation in

RIBS—*Continued.*

OPERATION.	RESULT.	REMARKS.
Resection of eighth rib with adherent parietal and diaphragmatic layers of pleura; diaphragm not perforated. Pleura freely opened; considerable dyspnœa for a few days.	Recovery in three weeks.	Successful operation for very extensive recurrence, three years later.
Resection of seventh rib, with adherent pleura; lung found fixed by old adhesions of upper lobe. No serious dyspnœa either during or after operation.	Slow recovery.	Very rapid recurrence and death.
Sub-periosteal resection of the cartilages, 2½ inches of each. The growth had invaded the mediastinum, but was removed without opening the pleura. Pulsation of right ventricle clearly seen.	Recovery in three weeks.	There was gangrene of a patch of skin over one of the cut ends of cartilage. No recurrence, nearly two years later.
Sub-periosteal resection of fifth and sixth ribs; pleura opened; lung collapsed. Wound in pleura sutured, save for a hole for drainage. Patient suffered intense shock.	Death a few hours after operation.	*Post mortem*, more than half a pint of blood in the pleura. Chronic degenerative changes in heart and lungs.

1882 for cancer of the breast, operated in 1885 for recurrent disease involving the ribs, and resected them over an area five or six inches in diameter. Caro reports the case of a woman, aged 55, whose breast had been removed in 1888; early in 1892, recurrent nodules were removed on two occasions; and later in the year recurrence took place over a wide area of the ribs. Free resection was made of two ribs: the pleura was avoided, but a small opening was made in the pericardium. Both patients recovered.

A careful study of the records of these tumours of the ribs and sternum will give clearly their chief clinical

features and their usual course. Several points are brought out very definitely; we see that they are, as a rule, painless, especially the enchondromata, at all events till they have attained a great size; that they are very often the result of some injury; that they may for many years grow very slowly, and then, either spontaneously, or after a blow, a puncture, or an incomplete operation, take on rapid growth.

The tumours of the sternum seem mostly to occur in middle life, and tend toward some form of sarcoma; those of the ribs occur in early adult life, and have more the character of enchondroma.[1] They may easily be mistaken for chronic abscess; and the still more grave mistake may be, and has been made, of operating on a syphilitic gumma in the belief that it is a new growth. Widespread adhesion of the pleura, the pericardium, or the diaphragm, and extensive disease of the lung, may take place without giving rise either to symptoms or to physical signs of their presence; and there is seldom any effusion into the pleura. But in a growth of long duration, near the heart, or over the lower ribs, one may suspect that the pericardium or the diaphragm is involved, if there be disturbance of the heart's action, or cough and hiccough.

As regards differential diagnosis, innocent growths, such as lipoma and fibroma, are extremely rare, and belong rather to the soft parts of the chest-wall than to the ribs. Exostoses never attain any considerable size, nor can one well mistake the feel of them. Chronic abscess may very closely imitate a new growth; and, above all, a syphilitic gumma may do this, so that with any swelling of ribs or sternum we must always keep in

[1] Out of 20 cases of tumours of the ribs collected by Speicher, 16 were enchondroma, and 4 sarcoma.

mind the possibility that it is due to syphilis. Finally, malignant disease of the chest-wall, receiving pulsation from the heart, has been mistaken for aneurysm; the converse error also has been committed.

The dangers that beset operation for tumours of the ribs and sternum are many and grave; but the results of the last few years are, on the whole, very encouraging. It is the cases that have been 'watched' for months or years that darken the results gained by surgery; and those also, where the patient has died either from neglect of the strictest rules of the antiseptic method, or from the excessive use of carbolic acid. If we take Campe's tables, and follow the operation stage by stage, we see first the need of a very free exposure of the growth, and this is best secured by a large flap, with convexity downward, of all the soft parts over it. Next, unless the growth be small, the surgeon may be sure he will open the thin, tense, adherent pleura, however careful he may be to avoid it; and he must have fixed in his mind, before the operation, the exact method by which he will deal with this dangerous trouble. He must further avoid every risk of hæmorrhage, after operation, into the pleural cavity. He must be prepared to deal with an adherent or diseased portion of the lung, the pericardium, or the diaphragm. Indeed, one might make a very long list of the risks that face him during, and after, the operation; but to do this would be only to re-write the records I have already quoted. Happily, the subject has also a brighter side to it; and there are plenty of successful cases to encourage the surgeon, especially if the growth has not long been noted, and if he is prepared to meet all the risks that have been enumerated, and others that may arise during the first few days after the operation.

CHAPTER XIV.

PLEURAL EFFUSIONS, OTHER THAN EMPYEMA.

We have come at last to the frontiers of the land of the physicians. There has long been a desultory sort of border warfare over this portion of their vast territory; and here we might stop to count what gains the surgeons have won from them, so far as our subject is concerned, and to consider whether we have any good hope of further conquest. But history tells us plainly that the physicians have done as much as the surgeons to advance the surgery of the chest, and rather more; and age after age thousands of lives have been lost because the surgeons who ought to have saved them were blinded by all sorts of false theories and idle speculations. As we should expect, the three men who have done most for the surgery of the chest are the first great physician, the man who first used the stethoscope, and the discoverer of the antiseptic method; and the three names of Hippocrates, Laennec, and Lister are, indeed, those that stand out above all the rest.[1] Next to them, we may put Trousseau and Dieulafoy for France, Schuh, Skoda and Fräntzel for Germany, Bowditch for America

[1] And o'er the plain, where the dead age
Did its now silent warfare wage—
O'er that wide plain, now wrapt in gloom,
Where many a splendour finds its tomb,
Many spent fames and fallen nights—
The one or two immortal lights
Rise slowly up into the sky
To shine there everlastingly.

Matthew Arnold.

and Douglas Powell and Godlee for England; and Ambroise Paré's name shall stand last, and out of place, that it may be next to that of the surgeon who has written so gracefully in honour of him. Hippocrates and his school treated empyema by free incision; they removed a piece of rib, let out the pus, and kept the wound open. Their art, like all Greek art, was lost; and there remained no clear rule of practice, nothing but a chaos of wrong speculations, and the loss of an incalculable number of lives. Between Hippocrates and Laennec, save Ambroise Paré, and Drouin (15th century), who first put a trochar and cannula into the chest, and, perhaps, one or two others, there are no immortal names, so far as our subject goes. What Hippocrates could do, in the pure air of Greece, was fatal when it was done in a mediæval hospital, or in the infected wards of the hospitals a hundred years ago; and if anyone will read the death-rates after operations at the Maison Dieu about that period, or how the women would pray on their knees not to be admitted to a certain lying-in ward of a great hospital at Vienna, he will understand how the minds of surgeons got to be set on avoiding operation, not on perfecting it, and they followed their own imaginations, and laid the blame on the patient, or the air, or on anything except themselves.[1]

The pleural effusions, other than empyema, are of several kinds; there is the ordinary effusion of pleurisy, the passive effusion (hydrothorax) in the last stages of cardiac or renal disease, the effusions, which may be mixed with air or blood, of malignant disease or of

[1] He who desires to read the history of the subject, should consult Trousseau's "Clinical Medicine," vol. iii. (Syd. Soc. Trans.), Fräntzel (Ziemssen's Handbuch, 1875), Gerhardt (Wien. Klin. Wchnschr.), 1891, p. 215, and Evans, "St. Thomas' Hosp. Reports," 1871.

advanced tubercular phthisis; there are the true 'hæmorrhagic pleurisies,' and there is chylothorax, from injury or disease of the thoracic duct; and pleurisy by traumatic infection, as where the pleura is accidentally opened during an operation. All these forms of effusion may need surgical treatment: let us then begin with the ordinary effusion after acute pleurisy, keeping to the surgical aspect of it. At what stage, and by what method, should the surgeon interfere? Having duly considered this question, let us then note the possible harm that may follow interference.

Ordinary Acute Pleural Effusion.

The rule that a simple serous effusion after acute pleurisy[1] should be for two or three weeks left untouched, has of late years been disputed; and it is a very pleasant occupation to trace its history; especially for a surgeon who has never understood the exact reasons for its authority. In so late as the fifth edition of Sir Thomas Watson's great work, we read, 'In simple pleurisy, puncture of the chest ought never, in my judgment, to be performed, unless the life of the patient is, or seems to be in jeopardy, from the continual presence of the liquid within the thorax.' Fräntzel, in 1875, recommended that you should not puncture the chest in simple pleurisy before the end of the third week, or until the effusion reaches the third rib, unless, for some reason, you are driven to it; Dr. de Havilland Hall, in 1876, said: 'If, after giving other methods a fair trial—and I consider three weeks to be ample time—there were then no

[1] Dr. Washbourn's paper, "Cases of Pleurisy caused by the Pneumococcus," in the Med. Chir. Soc. Trans., 1894, p. 179, gives valuable guidance for the recognition of those cases of acute pleurisy which most closely imitate pneumonia.

signs of absorption to any marked extent, I would advise puncture.' Gerhardt, in 1891, says that puncture ought not to be made before three weeks after the beginning of the illness, unless there is some special cause for it; and Dr. Clifford Allbutt, in 1894, says: 'As a general rule, if an effusion rises much above the angle of the scapula, and abides in this quantity or more for two or three weeks, in spite of adequate treatment, it must be drawn off, whether the patient be embarrassed by it or not.'[1]

It is plain that the practice of waiting till the patient was in danger of death came through the fault of those surgeons who, by the use of trochars not sterilized, converted a serous effusion into a purulent one; or, even if it stopped short of this, yet the puncture was followed by increase of fever, and by a rapid fresh accumulation of the fluid up to a level as high as it was before, or higher. To wait till the patient is nearly dead is a rule that may be dismissed with a reference to a case recorded by Fräntzel: 'In 1867, a case came under my care where operation was indicated, but as it was late in the evening, I put it off to the next morning. That night, the patient suddenly called for help, and the nurse, on coming to the bedside, found him dead. The *post mortem* examination showed the whole of the left pleura full of a serous effusion; the displacement of the organs was so great that the vena cava inferior was kinked almost to a right angle, where it passes through the diaphragm.' We are now more likely to go to the other extreme, and to puncture the chest even for effusions of moderate size, which neither trouble the patient nor endanger his life

[1] For references, see "St. Bartholomew's Hosp. Reports," 1876; Quain's Dictionary, new ed., p. 474; "Wien. Klin. Wchnschr.," 1891, p. 215; also "Brit. Med. Journ.," July 13, 1895, and "Lancet," Nov. 2, 1895.

or his lung. But it is certainly better to be too soon than too late. It is not likely that the lung will be damaged by our waiting, or that a few days' delay will make any difference by allowing adhesions to form, or by increasing the risk of thrombosis of the pulmonary artery; still, these things are not impossible; and in any doubt, the decision should be in favour of operation.

The choice of the method of operation at the present day is between aspiration and incision; putting aside cases of emergency, where relief must be given by whatever method comes to hand. Simple puncture with an ordinary trochar and cannula will not always serve instead of aspiration; it may be successful, or it may fail to withdraw a sufficient quantity of fluid. 'There is always this one drawback to simple puncture without aspiration, that a good quantity will flow only so long as the internal pressure is higher than the pressure of the atmosphere; when the two become equal, then it is only on forced expiration, such as coughing, that a few drops of fluid can be let out, even though there are many pints in the chest; I have frequently observed this. In one case, that of a man, aged 75, who was unable to give a good cough, hardly a drop flowed. And it is impossible to tell beforehand the degree of the internal pressure; generally, it is highest in recent effusions with displacement of the organs: but this rule is not absolute—even in such cases, I have failed to draw off more than a few drops of fluid by simple puncture without aspiration.' (Fräntzel.)

The choice, then, lies between aspiration and incision; and it is only in the last year or two that we have had any choice at all in the matter. In April, 1895, Dr. West published a case of pleural effusion cured by incision after several aspirations had failed, and in July a

similar case was published by Mr. Rutherford Morison; and in November, 1895, three cases were reported at a meeting of the Medical Society by Dr. A. Wilson, of Leytonstone, of free incision without previous aspiration. Of course, in a case of emergency, one must open the pleura with whatever instruments are to hand; but, except for emergency, I cannot see that incision has any advantage over aspiration; it is more alarming, and more painful, for the patient, and affords at least a possibility of troubles which cannot follow aspiration; it is true that it avoids other troubles that aspiration may bring with it, but I think the balance of advantages is in favour of aspiration, and incision should be kept for cases where there is urgent necessity for immediate operation, or where aspiration has failed.

And as regards the point at which the needle is to be introduced, we need not review the vast array of former opinions: some of them rested on doctrines of pressure and of equilibrium, which have no immediate application to practical surgery. One must not go too low, for fear of wounding the diaphragm, and because fibrinous masses may block the needle here; but even these apprehensions may be more theoretical than real. We may take Mr. Godlee's rule for empyema: 'Opposite the ninth rib, just outside the angle of the scapula,' or, as Dr. Clifford Allbutt puts it, 'The eighth space, in a line with the angle of the scapula, or a little outside.' But in particular cases, there may be reasons for choosing some other point.

Risks of Aspiration. Sudden Œdema of the Lung.

These slight operations are not wholly free from risk. One is hardly likely to wound the diaphragm or the abdominal organs—nor, if one did, would it be much

consolation to remember that the same thing was done by Laennec himself. Nor is there much excuse for a surgeon who wounds the lung; this has often been done, and I know of a case where it ended in death. If the needle gets blocked, and cannot be cleared with a stilette, it is better to puncture in a fresh place than to try to clear the needle by syringing down it. Nothing but harm can come of withdrawing the effusion too rapidly; what the Germans call 'aspiration in a storm.' Though there is no certain evidence that aspiration, however violent, can actually rupture the lung, yet it may cause it to bleed, may excite bleeding from the pleura or from recent adhesions, or may provoke painful coughing; above all, a rapid aspiration is dangerous, because it may bring about sudden faintness, or may even set up that most dangerous condition known as acute œdema of the lung, or serous œdema, the 'expectoration albumineuse' of Terrillon.

The syncope that may follow the too rapid escape of a pleural effusion may be compared with that slighter degree of faintness which may follow the sudden emptying of a distended bladder, or even the evacuation of an over-loaded bowel. Inasmuch as it comes of simple loss of intra-pleural pressure, it is somewhat different from those strange cases of syncope that follow irrigation of the cavity of an empyema, which are given in chapter xvii. Though, as a rule, it occurs during or immediately after the operation, it may be delayed, as in a case recorded by Sir William Broadbent,[1] where a man, aged 62, with a large left pleural effusion, died suddenly three and a half hours after aspiration. Should the patient become faint during the withdrawal of the fluid, the surgeon ought

[1] "Clin. Soc. Trans," 1877, x. 24.

at once to leave off, and not, as one authority has advised, to wait till he revives, and then go on.

Serous œdema of the lung,[1] with profuse albuminous sputa, is a disaster so strange and so alarming, and the explanation of it is of such interest, that it may be worth while to spend some time over it. Happily, it is rare; unhappily, nothing can be done either to foresee, to prevent, or to alleviate it. In its worst form, it is a sudden swamping of the expanding lung by the transudation of serous fluid into its substance; an invasion of the air-vesicles, so general and so rapid, that the patient may die almost at once, a profuse frothy serous expectoration obstructing his air-passages and suffocating him. In a less severe degree, he suffers oppression, distress, and difficulty of breathing, he is somewhat cyanosed, and is seized with a paroxysmal cough, with profuse expectoration, perhaps a quart altogether, of clear frothy serous fluid; the attack may last some hours, or even a whole day, slowly abating its intensity till the lung again acts naturally. In the least severe degree, there is but slight dyspnœa, no marked distress, and a less profuse expectoration, but of the same characteristic clear, yellowish, thin, frothy fluid, separating on standing into yellowish froth on the surface, then serous alkaline fluid giving an abundant coagulum of albumen, then a deposit at the bottom of the vessel of epithelial cells and blood corpuscles. During the attack, if it be at all severe, fine crepitant râles may be heard in great abundance, especially over the base of the lung.

---

[1] This account of it is an abstract of Terrillon's delightful essay, "De l'expectoration albumineuse après la thoracentese." Paris, Baillière et Fils, 1873. See also a good case by Kovacs, Ueber einen Fall von acutem Lungenœdem nach Thoracocentese, "Wien. Klin. Wchnschr.," 1891, p. 41. Also "Clin. Soc. Trans.," April, 1896.

There is usually an interval, from ten minutes to an hour, between the completion of the operation and the onset of the expectoration; in two instances, there was no interval; in two, it lasted several hours. So long as it lasts, minutes or hours, the patient appears to be well, and to enjoy full relief from the operation. The duration of the attack may be only a quarter of an hour, or several hours, or even, as in one case, two days; the total quantity of the expectorated fluid may come to two or three pints.

There was nothing in the history of the cases collected by M. Terrillon, in the character of the pleural effusions, or in the course of the operations, to account for it; most of them were ordinary serous effusions after acute pleurisy; only three out of the twenty were passive effusions (hydrothorax) due to disease of the heart. But it is especially to be noted that the effusions were large, on an average three and a half or four pints, and that in every case they were withdrawn from the chest rapidly and in a continuous stream.

The old explanations (1,) that the lung was wounded with the trochar so that the pleural effusion got into the bronchi; (2,) that there was a fistula in the lung, which was opened up by the sudden expansion of it, thus admitting the pleural effusion into the bronchi; (3,) that in some mysterious way the pleural effusion was suddenly absorbed into the lung, and thus into the bronchi; none of these three theories will stand examination. There is, indeed, only one possible explanation, that the rapid expansion of the lung is followed by some vaso-motor change in the walls of its capillary vessels, allowing the serum of the blood to escape into the alveoli.

In 2 of the 21 cases collected by M. Terrillon, the patient died, almost at once. 'Immediately after the

operation he was relieved, had no cough, and seemed in every way doing well. About twenty minutes later, he was suddenly seized with dyspnœa, which rapidly became intense, with a hacking cough and profuse frothy expectoration; then came an agonized struggle for breath; then, after a few minutes of terrible anxiety, during which his breathing was almost arrested, the fluid poured in a stream from his mouth, he became cyanosed, and died.' In the 19 cases not fatal, the distress, cough, and other signs of the fluid in the lung were of different intensity and duration in different cases, but in all they were well marked.

The case published by Kovács is worth careful study. The patient, a woman, aged 58, given to drink, and generally unsound, had a left pleural effusion; aspiration, done slowly, drew off a pint and a half, and was then stopped on account of a violent fit of coughing. A few minutes later, the cough returned, and she began to expectorate a quantity of yellowish serous frothy fluid, which became more and more profuse, with dyspnœa, and a pulse that could hardly be felt; fine crepitant râles and moist sounds were heard over both lungs, but chiefly over the left. In spite of active stimulation she became collapsed, the fluid was no longer coughed up, loud râles in the larger bronchi were now audible, even without applying the ear to the chest. In spite of this alarming condition, she pulled through the night, and was a little better next morning; sputa still copious, serous, frothy, tinged with blood, and loaded with albumen; the urine contained albumen, and hyaline and fatty casts. On the third day, the sputa were scanty, blood-stained, then viscid and rusty, like pneumonic sputa. In the first 48 hours, there was collected over a pint of the serous fluid sputa; specific gravity 1011, loaded with albumen. Seven or

eight weeks later it was again necessary to operate; only about a third of a pint was very slowly drawn off; but all the former dyspnœa and profuse albuminous expectoration again occurred; after this, nothing more was ventured, and she died in very great distress ten days later.

It might be possible, in such a case as this, to use Southey's trochars at the second operation, with very gradual syphon-drainage. During the attack itself, one can but keep the patient going with brandy, hypodermics of strychnine, and other stimulants; no good is likely to come of artificial respiration; the administration of oxygen, if it were available, would probably be of great value.

Secondary Pleural Effusions.[1]

We come next to those cases of secondary serous effusion which follow diseases other than pleurisy. Such effusions are often mingled with blood, or with débris of the primary disease, if it be in the lung; in this case, air, as well as fluid (hydro-pneumothorax), may be present in the pleura. In the last stages of chronic cardiac or renal disease, in the exhaustion of advanced malignant disease, or after one of the specific fevers, a passive serous effusion may occur in one or both pleuræ, without fever, or much pain or coughing, unmixed with blood, free from fibrinous deposits or loose coagula, a true dropsy of the pleura, now called hydrothorax; a condition more often noted in the *post mortem* room than needing treatment in the wards; what used to be called

[1] See Fräntzel *loc. cit.*; Netter, "Wien. Med. Presse," 1892, p. 33; Litten, "Verhandl. d. Congr. f. Inn. Med.," 1885-86, p. 417; Lawson Tait, "Med. Chir. Trans.," 1892, p. 109; Freyhau, "Wien. Med. Presse," 1892, p. 185.

'water on the chest,' and was in the days before Laennec often assumed to be present, and to be the cause of death, in cases where it was absent; and was often confounded with the effusion of acute pleurisy. The fever, cough, and pain of acute pleurisy,[1] are absent; both pleuræ are often affected, and thus there is probably no marked displacement of the organs; the presence of old adhesions may limit or subdivide the effusion, but should it rise high the results of its pressure are very severe, as the patient is already enfeebled by disease. The treatment must of necessity be limited to relief of the distress by aspiration; and should the heart's action be feeble, even this will not be without some risk: in one of Terrillon's cases, aspiration for hydrothorax secondary to disease of the heart was followed by acute œdema of the lung: when it became necessary to repeat the operation, every precaution was taken to strengthen the action of the heart, and this time there was no œdema.

In tubercular phthisis, a minute opening may come in the surface of the lung, from softening of a small focus of the disease, and the pneumothorax that may follow may be attended by a non-purulent pleural effusion, distinct from that form of empyema which follows the giving way of a cavity in the lung. Netter examined the effusion in sixteen cases of this non-purulent tuberculous hydro-pneumothorax. In every one, the tubercle-bacillus was present, but the ordinary micro-organisms of

[1] The cough in the early stage of acute pleurisy is not due to direct irritation of the pleura—for this, as Nothnagel showed by experiment, does not cause cough; but to the beginning of compression of the lung by the effusion. The intercostal pain, or stitch in the side, is an early, definite, and constant sign. Valleix found it in 40 cases out of 46. Both cough and pain tend to disappear as the effusion grows larger.

suppuration were absent; and guinea-pigs inoculated with the fluid developed general tuberculosis. This non-purulent effusion may become purulent by subsequent infection, by the giving way of a cavity in the lung, and then the ordinary micro-organisms of suppuration and putrefaction will be present, together with the tubercle-bacillus; but there are cases where it has remained non-purulent, and has been improved or even cured by simple aspiration—a true tuberculous hydro-pneumothorax, a direct inoculation of the pleura, as if for an experiment, with the tubercle-bacillus. One may get a similar effusion, but without pneumothorax, in primary tuberculosis of the pleura, a disease very rare at any age, but even more so in childhood than in late life.

Next to be considered are those pleural effusions that follow the invasion of the lung by strange parasitic organisms, spirilla, or protozoa; a group of cases belonging rather to pathology than to surgery, but useful here as emphasizing the need of careful microscopic examination of the fluid in any unusual case of pleural effusion. In the case of acute œdema after aspiration, quoted from Kovács, the pleural fluid contained the micro-organism called 'Curschmann's spirillum,' found also in cases of gangrene of the lung, chronic bronchitis, and bronchiectasis. In a case of hydro-pneumothorax, Litten found in the fluid flagellate protozoa, resembling spermatozoa, and the same organisms have also been found in gangrene of the lung, and, by Grimm, in a case of abscess of the lung with abscess of the liver. Of vegetable parasites, aspergillus, such as one sometimes sees in the external auditory meatus, has been found in the lung[1]; and Freylau has published

[1] Dr. Bristowe and Dr. Wheaton, "Path. Soc. Trans.," vols. v. and xli. See also chapter xxvi.

the case of a man, aged 22, with a hæmorrhagic effusion in the left pleura, in whose sputa were found masses of mycelial growth with conidia. As regards actinomycosis of the lung, the disease itself is not here to be considered; and it tends rather to adhesions of the pleura than to effusions into it; or the effusion is purulent from the very first. Pleural effusions, purulent or sero-sanguineous, have been recorded by Mr. Shattock and Dr. Delépine in cases of actinomycosis of the liver, but these were due to general septicæmia, or to infection by contiguity.

Litten's case is worth reading, not because of the flagellate protozoa found in the fluid, but for the marked physical signs that it presented :—

A man, aged 34, after 'inflammation of the lungs,' was found to have an enormous effusion into the right pleura, reaching up to the second rib, and displacing the diaphragm and the heart. Simple puncture, without aspiration, let out more than five pints of serous fluid, to his great relief. Eight days later, the fluid had re-collected; when he stood upright, it reached as high as the third rib in front; when he lay down, it only reached to the sixth rib. Now, too, he complained of a peculiar sound in his chest, which his wife had pointed out to him, as it was heard when he moved in bed; a gurgling note, such as one gets by shaking water in a half-empty bottle; and when he shook himself, a splashing sound (*succussio Hippocratis*) was plainly heard, even at some distance. The opening in the lung, probably due to rupture of a softened spot by the withdrawal of the fluid, was now beneath the level of the fresh collection of fluid, and was closed by its pressure, like a valve; at times, one could hear air-bubbles, having escaped from the lung and risen through the fluid, break on the surface of it with a metallic splashing sound; and when the second effusion was withdrawn, air could be heard whistling through the opening in the lung, or could be made to whistle through it by further exhausting the aspirator.

The serous effusions that may attend these rare infec-

tive processes in the lung are often bloodstained; and every suspicious effusion, and the patient's sputa, should be carefully and repeatedly examined with the microscope. But a blood-stained serous fluid is more likely to be due, not to these, but to tubercular phthisis or malignant disease. This is not an absolute rule; the chance rupture of an old adhesion may stain the fluid with blood; or an effusion in an old person may have blood in it, without either tubercular or malignant disease; or a chronic pleural effusion may contain old broken-down blood, as in a case of double hæmorrhagic pleurisy, of long standing, with blood and cholestearin in the fluid, reported by Dr. Churton, in the "Clinical Society's Transactions" for 1882. Still, a hæmorrhagic effusion is, almost certainly, a sign either of tubercular or malignant disease of the lung or pleura, at whatever age it occurs. Thus, Hofmokl[1] gives a case of myxo-sarcoma of the pleura, in a child, only $3\frac{1}{2}$ years old, with blood-stained fluid in the pleura. In a case of 'diffuse endothelial cancer' of the pleura in a man, aged 42, Rossier[2] drew off blood-stained fluid, of specific gravity, 1013, containing a quantity of albumen, a trace of sugar, blood corpuscles, and a quantity of degenerate epithelial cells. It would be easy to give a number of references to the blood-stained effusions of malignant disease; but I am not sure that the effusions in cancer of the pleura secondary to scirrhus of the breast are so often blood-stained, as those in primary sarcoma of the pleura or of the lung. In a case of my own, where I had repeatedly to aspirate the pleura for effusion due to recurrent cancer

[1] Beiträge zur Lungenchirurgie, "Wien. Med. Presse," 1892, p. 1904.

[2] Travaux de l'Institut Pathologique de Lausanne, Jena, 1895.

after removal of the breast, the fluid was not even tinged with blood.

A hæmorrhagic effusion may occur in cases of abdominal tumour, and is an almost certain proof that the abdominal disease is malignant, and has invaded the diaphragm. But even this rule has found its exception. Mr. Lawson Tait[1], after giving a case of hæmorrhagic left pleural effusion, due to medullary cancer of the ovary, with fungating secondary growth on the pleural surface of the diaphragm, and after referring to many similar cases, gives a case of simple fibrous tumour of the ovary, in a patient, aged 36, ending in recovery after operation, where there was double hæmorrhagic effusion; in the right pleura, blood; in the left, nearly five pints of blood-stained serum at the first aspiration, and four pints of pale serous fluid unmixed with blood, at the second.

In tubercular disease, as Moutard-Martin has shown in his very valuable essay, "Etude sur les Pleurésies Hémorrhagiques" Paris, 1878, a hæmorrhagic effusion is a sign of the acute miliary non-ulcerative form of the disease, never of the common ulcerative form. He gives notes of nineteen cases: of these, in two only was the effusion so large as to make puncture necessary. All the patients died in Hospital, the great majority within three or four weeks of admission.

These secondary pleural effusions, and the cases I have quoted, both those that prove the accepted rules of pathology, and those that are exceptions to them—at least agree in one respect, that they emphasize the need of very careful microscopic examination of the fluid and sputa, in every case of pleural effusion that is in any way unusual or suspicious.

---

[1] "Med. Chir. Soc. Trans.," 1892, p. 109.

CHYLOTHORAX.[1]

There are a few recorded cases, where from injury or disease of the thoracic duct, the chyle has passed into one or both of the pleural cavities. The condition is so rare, that we have only to note its possibility, and to remember that, if the opening in the duct remains unclosed, the patient will surely die of slow emaciation. Some of the older cases, supposed to be chylothorax, appear to have been really empyema; and it is also possible to mistake for true chyle the turbid fluid, mixed with degenerate epithelial cells and other débris, that may come with tubercular or malignant disease of the pleura. Wounds of the thoracic duct in the neck during deep operations in its neighbourhood[2] have often been recorded; but of direct wounds of the duct within the chest we really know nothing. But there are one or two cases of indirect injury of this part of the duct by a severe fall, or by a crushing of the chest; and where there is no history of any injury to account for the giving way of the duct, we must suppose that some acute or chronic ulceration or obstruction has brought about first thinning and then laceration of it.

1. A man, aged 35, was crushed between the wall and the heavy roller of a machine, in such a manner that *his spine was forcibly extended and bent far back*, and he was fixed for some time, screaming with pain, before he could be set free. No serious injury was discovered at the time; but

---

[1] See Port, "Deutsch. Ztschr. f. Chir.," 1894, xxxix., p. 572; Neuenkirchen, "Wien. Klin. Wchnschr.," 1891, p. 638; Weischer, "Deutsch. Ztschr. f. Chir.," 1894, p. 487; Keen, Philadelphia, 1894; Kirchner, "Arch. f. Klin. Chir.," 1885; Boegehold, "Arch. f Klin. Chir.," 1893

[2] I have heard of a fatal case of chylothorax, with solid œdema of the arm, after severe and repeated operations on a boy for the removal of enlarged axillary glands.

three days later, he complained that he had pain on breathing; next day his breathing was laboured, and some blood-stained fluid was withdrawn from the right side of his chest, but without giving him much relief. About a week later, reddish-white milky fluid was withdrawn, and was recognised as chyle, and he was sent to the Hospital. On admission, he was well-nourished, free from fever; face slightly cyanosed, breathing laboured; signs of effusion in lower part of right pleura. Preliminary puncture drew off reddish-white milky fluid; the needle was left in as a guide, a piece of rib was resected, and between four and five pints of thin milky fluid were let out, free from blood-clot or masses of fibrin, and the cavity was drained. The fluid, under the microscope, was found to be almost wholly globules of fat of different sizes, with a few white and red blood cells; it was perfectly sterile. The lung expanded rapidly; the dressings were soaked through the day after the operation, but not afterward; the drain was left out on the third day; he made an uninterrupted recovery. His rapid healing (since it is not likely that he had a double duct, or that any sort of collateral circulation of the chyle could be established) must be attributed to closure of the rent in the duct, either by pressure of the effusion, or by alteration in the position of the parts from expansion of the lung.

2. A little girl, aged 9, received a contusion of the front of the chest, at the level of the third ribs. In the course of the next fortnight, there appeared signs of right pleural effusion—cyanosis, sweatings, dilatation of the alæ nasi, inability to lie down, fulness of right side of chest up to third rib, displacement of heart and liver; temperature normal. Puncture in the fifth right space let out nearly a quart of milky fluid, which, under the microscope, was found to be chyle. Ten days later there was again marked dyspnœa, but under treatment with warm baths and gentle purgatives, the child improved, and made a complete recovery.

3. A woman, aged 47, had chronic chylothorax; at different times each pleura had been affected; the disease always ran its course without fever, and the fluid always recollected, in one pleura or the other, after aspiration. That the case was one of true chylothorax, and not of pleural effusion with admixture of débris from tubercular or malignant disease, was shown by the microscope and by analysis. There was no history of injury, no fluid in the abdominal cavity; it must, therefore, be supposed that the duct had given way after some inflammation of its walls.

Kirchner and Keen have collected between them twenty cases of wound of the duct, but we are here concerned only with its thoracic portion. In wounds of its cervical portion, by a stab, or in deep operations on the left side of the neck, the fluid that escapes is clear and pale; the patient has been kept without food before the operation, or it is a lymph-trunk that has been wounded, not the duct itself; in chylothorax, the fluid is opaque like milk, and coagulates on removal into a firm gelatinous clot. Of the twenty cases, four were injuries of the cervical portion, all during an operation; six were abdominal effusion; nine were chylothorax, and one was effusion of chyle into the mediastinum. Of disease, as a cause of chylothorax, we know very little; the duct may be blocked with a calculus, or with tubercular disease; one case of each kind has been recorded.

Boegehold, in a series of experiments on dogs, in two instances made a transverse wound of the duct at its entrance into the veins; pneumothorax followed, but no chylothorax, and the wound was healed with a fibrinous deposit round it. In three instances, he wounded the duct; chylothorax followed, and death in a few days from compression of heart and lung. In one, he first tied the duct in the neck, then, on the fourth day, opened the pleura, found the distended duct, and made a very small wound in it. The animal was killed three days later; the wound was found sealed with a small red fibrinous clot, and very little chyle had escaped.

The pressure within the thoracic duct is slight, and the duct has some power of muscular contraction—it has been found, two hours after death, that a firm and lasting contraction of its walls follows the application of electricity from an induction-coil. Experiment shows that the wound in the duct will soon be healed with a

fibrinous clot, if only circumstances allow it. It appears, therefore, that one should treat a case of chylothorax by absolute rest, forbidding milk and all food containing fat, and by withdrawing a portion only of the effusion to relieve pressure, leaving the rest. I can find nothing to show that an attempt has ever been made to do more than this, or that it would be justifiable.

NOTE A.—Gilbert, of Geneva, on the strength of Debove's observation that the effusion in tuberculous patients contains products analogous to if not identical with tuberculin, has tried using this organic fluid to arrest the very disease that gave rise to it. In a case of tuberculous pleurisy with effusion, having examined the fluid with a Pravaz syringe, he withdraws the needle part of the way, then thrusts it into the soft tissues, and here makes a subpleural injection of the fluid. He and others have used this method in 21 cases, and report that 19 were thus cured: but I do not know what certain proof he had that actual tuberculous disease of the pleura was the cause of the effusion.

NOTE B.—There are two valuable papers on Chylothorax, by Dr. Sidney Martin and Dr. Turney, in the "Pathological Society's Transactions," for 1891 and 1893. In one case, there was occlusion of the left subclavian and internal jugular veins: in the other, probably blocking of the duct by a cancerous embolus from cancer of the pylorus.

CHAPTER XV.

EMPYEMA.

It is hard to attempt the great subject of empyema, or to present in a proper order even a small part of the vast literature that has gathered round it. The only way to make these chapters useful is to put in the foreground those difficulties and abnormalities that we must be prepared to meet, rather than those cases, my own or others, that ran a smooth and uneventful course, and to note such things only as have a direct bearing on questions and methods of surgical treatment.

History.

If we look again at history, we find whole ages of neglect or perversion of the truth; and it is impossible to understand how the Hippocratic treatment of empyema became so hopelessly lost, when we read the description of it in the works of Hippocrates himself. The teaching of Hippocrates was as follows: Having carefully washed your patient with warm water, you must seat him on a firm chair, and then, while your assistant steadies his hands, you must gently shake him by the shoulders, in the hope of obtaining a splashing sound in the affected side of the chest. Operation should not be performed before the fifteenth day after the beginning of his illness. An incision must be made through the skin, where the pain and the swelling are most evident, and then the pleura must be opened, either by trephining the rib, or with a sharp instrument, or with the actual cautery.

When a sufficient quantity of pus has been let out (and those who suffer from empyema or dropsy of the chest are sure to die if you *rapidly* evacuate the pus or the water), you must keep the wound open with a strip of linen cloth, secured with a thread. This strip must be removed daily, that the remainder of the pus may run out. On the tenth day after the operation, you must irrigate the cavity with warm wine and oil, for the purpose of cleansing the surface of the lung; these irrigations must be made twice a day. Finally, when the discharge has become thin and serous, you must keep a small rod of metal in the wound, using a smaller size from time to time, till the whole wound has healed.

If it be true that Galen invented an aspirating syringe, this was probably the beginning of the evil; the Hippocratic operation fell into disrepute, and there was no method to take its place: incision, either with the knife or with the actual cautery, was almost wholly abandoned, save by some of the Arabian physicians. By the time of the Renaissance, with the return to Greek art and literature, it was too late to go back to Hippocrates. Surgery had become embarrassed by the bad results of septic wounds, and it was held to be as dangerous to let air into the pleura as to leave an effusion unrelieved; nor was the difference between serous and purulent effusions properly recognized. Thus it happened that our art drifted, in spite of Ambroise Paré and Guy de Chauliac, into that disastrous period when empyema was treated by simple puncture; and not even Laennec could save it. The doctrine that puncture for a serous effusion would convert it into a purulent effusion, and that the entry of a few air-bubbles into the pleura might set up a fulminating suppuration, blocked the way; and blocked it still might be, but for Lister. The history of the treatment

of empyema, from Hippocrates to Lister, would justify a revival of the oath of Hippocrates, 'in purity will I practise my art,' if it were understood that the purity must be not only a virtuous life, but also a method of operating.

For example, so late as 1872, M. Bouchut published, as an instance of good and profitable surgery, a case of empyema in a boy aged nine, cured in sixteen months after fifty-eight punctures. In another case, he punctured the chest, in eleven months, a hundred and twenty-two times. Lilly records a case where he made fifty-six punctures. Gimbert, in a child eleven years old, made seventy-four punctures in nine months, obtaining a grand total of thirty pints of pus. And the worst of it all is, that out of forty-eight patients thus tormented, only six were cured.

Nor did free incision, before Lister, fare much better. Out of twelve cases, under the care of Velpeau, not one recovered; out of fifty cases, under the care of Dupuytren, all but two died; and Sir Astley Cooper complained that he 'could never get a single cure.'

Here are three cases, less than twenty years ago, whose lives might have been saved if they had been under the care of Hippocrates.

1. A man, aged 33, was admitted to Hospital, in the first stage of acute pleurisy, on Oct. 25th, 1881. During the next eight weeks he was punctured thirteen times, giving a grand total of eighteen pints of pus. Four days after the last puncture, a small tube was passed into the chest through a small hole made with a trochar. 'In spite of irrigation, signs of purulent absorption continued, the discharge began to smell gangrenous, the patient got steadily worse, and died on March 7th, 1882. The *post mortem* examination showed a large cavity, its walls not yet much thickened; the lung was not wholly collapsed; the kidneys showed commencing amyloid disease.'

2. A man, aged 40, was admitted to Hospital, on the

seventh day of an acute pleurisy, on Nov. 27th, 1877. During the next eleven weeks, he was punctured fifteen times, giving a grand total of sixteen pints of pus. By the time he had been punctured five times, the effusion, sero-fibrinous at first, had become wholly purulent; by the time he had been punctured fourteen times, it was putrid and mixed with gas. Now at last an incision was made, and the cavity washed out. 'Two years after admission, healing appeared complete, when, on December 7th, 1879, he was suddenly carried off by uræmic convulsions.' *Post mortem*, marked amyloid disease of liver and kidneys.

3. A man, aged 51, was admitted to Hospital, seven weeks after the onset of acute pleurisy, on Oct. 3rd, 1887. During the next seventeen weeks he was punctured nine times, giving a grand total of nineteen pints of pus. Abscesses formed at the seats of puncture. The last puncture let out gas with the fluid. Three days later, an incision was made, and the cavity washed out. 'But the patient was already very feeble, exhausted by many months of profuse suppuration: in a few days he was carried off by an attack of erysipelas starting around the incision.'

It is sometimes said that surgeons fifty years hence will think as little of our results as we think of the methods of fifty years ago. So far as regards the surgery of the chest, this is utterly untrue. Fifty years ago, it had risen above the horizon, it is now nearly at its zenith. Indeed, it is possible that we may see its upward movement checked; there are signs that some of the operations that have been proposed and performed for apical phthisis and for bronchiectasis are falling out of favour with surgeons.

Bacteriology.

But we are concerned at present with empyema, and the first thing to consider is the natural history of the disease. From the bacteriological point of view, an account of empyema could be written according to the natural history of the different micro-organisms present

in the fluid.[1] In simple serous effusion, according to Kracht, no micro-organisms are present; in empyema following pneumonia, the active micro-organism is the pneumococcus of Fränkel; in the early stage of this form of empyema, this alone may be found; and since it has but a limited term of life, it may fail to overcome the resistance of the tissues, and may die, and the effusion, to which it has given rise, may undergo degenerative changes, and finally be absorbed. It is certain that an empyema after pneumonia, especially if it be of small extent, or in a child, may be absorbed. Pel[2] records three cases, all of them small circumscribed empyemata, toward the posterior part of the chest: two were after pneumonia; in the third, the cause of the disease was doubtful. In all, the diagnosis was confirmed by puncture: all became absorbed, and it is certain that none of them broke into the lung or the alimentary canal. Bouveret[3] records a similar case. After a time, even if the pneumococcus be at first the only organism, other forms of life outnumber it—streptococci and staphylococci, the active organisms in all ordinary cases of empyema. A special form of bacillus has been found by M. Bouchard in the blood, and in the pleural effusion, of those cases of very rapid septic pleurisy, with acute swelling of the spleen, high fever, delirium, and a typhoidal condition, first described by Fräntzel in 1877.[4] The bacillus of

---

[1] See Dr. Bayard Holmes, "Journ. Amer. Med. Ass.," April 4, 1891; and Immermann, "Verhandl. d. Congr. f. Inn. Med." Wien, 1890, p. 19.

[2] "Zstchr. f. Klin. Med.," Berlin, 1890, xvii., p. 199.

[3] "Traité de l'Empyème," Paris, 1888. The possible absorption of a small passive empyema of this nature is of course only a curious fact in pathology, not a reason against operating.

[4] For full account and references, see Bouveret, "Traité de l'Empyème," 1888, p. 419.

typhoid (Eberth's bacillus) has been found in pleural effusions after typhoid fever. References to work recently done in America on the bacteriology of empyema, will be found in a valuable paper by Dr. White and Dr. Wood, in the 'Therapeutic Gazette,' Detroit, Aug. 15, 1894 In those strange cases of empyema where the effusion is a thin, dark, turbid, horribly offensive gangrenous fluid—the so-called 'putrid empyema'—higher forms of life are found; chains of bacteria, leptothrix, various amœbæ. And mention has already been made of the presence of spirilla and of flagellate bodies in some secondary serous effusions, and of the combination of micro-organisms in tubercular empyema.

There are other considerations in the natural history of empyema that belong to bacteriology. The pericardium, the pleura, and the peritoneum are all alike in structure and in function, yet they differ widely in their power of resisting infection; and this Dr. Bayard Holmes explains by saying that the peritoneum, being always in close proximity to infective material in the alimentary canal, has acquired a power of resistance higher than that of the pleura or the pericardium. Again, by what process do the organisms of suppuration gain access to the pleura, when we know that the lung-tissue is 'almost as impervious to germs as the wad of cotton with which we stop our test-tubes?' These, and the like subjects, belong to bacteriology; but the facts that I have quoted as to the variety of organisms found in serous and purulent effusions show the value of making careful microscopic examination of the fluid in all unusual cases.

But we are now taking a surgical view of empyema: and it is difficult to know where to begin, or how to present in the right order what is most useful to the surgeon in

the literature on this subject.[1] Perhaps it will be best to take first the general character and signs of empyema; next, the course it tends to follow when left to itself. The operation, and the difficulties that may attend or follow it, and the cases of chronic empyema and their treatment, require separate chapters.

The General Character of Empyema.

That empyema is not a rare disease of the chest, and that it is often fatal in spite of surgery, is shown by the statistics lately published here and abroad. Thus, Immermann has published 74 cases, and Hofmokl 60; König had 76 cases in twelve years; Pel, of Amsterdam, had 100 cases in eight years; and in Great Ormond Street Hospital, during thirteen years, 1880-1892, there were 214 cases. Pel, writing in 1890, believed that the disease is on the increase. Our estimate of the mortality from it must vary according as we include or exclude the numerous troubles that are more or less a part of it. Bouveret, in 1888, collected 175 cases, with 55 deaths; König, in 1891, published his 76 cases, with only 10 deaths; Hofmokl (1889), of his 60 cases, lost 28; but of these, no less than 13 died of tubercular disease, 6 of pneumonia, 3 of pericarditis, 3 of peritonitis, and 1 each of amyloid disease, heart failure, and malignant disease. Foltanek,[2] in 1891, pub-

[1] See especially Bouveret, "Traité de l'Empyème," Paris, 1888. Immermann, "Die Behandlung der Empyeme," ix. Congress f. Inn. Med. Wien., 1890; Pel, Ueber die Behandlung der Pleural-Empyeme, "Ztschr. f. Klin. Med.," Berlin, 1890, xvii.; Schede, "Die Behandlung der Empyeme," ix. Congress f. Inn. Med. Wien., 1890; König, "Wien. Klin. Wchnschr." 1891; Hofmokl, "Klin. Zeit und Streit Fragen, Wien," 1889, vol. iii. Of English surgeons, Mr. Godlee and Mr. Pearce Gould (British Medical Assoc., Nottingham, 1892), and Mr. Pitts' Lectures, "Lancet," Oct. 1893. Other references are given where necessary.

[2] "Jahrb. f. Kinderheilk," xxxi., 3.

lished 21 cases of empyema in children, treated by incision without resection, with only 4 deaths. Immermann (1890), of his 74 cases, lost 20; but 17 of the 20 died from tubercular disease, or septic infection, or other causes than the empyema itself. Dr. Lewis Marshall[1] (1895) gives 45 cases, at all ages, with 7 deaths; Dr. Cautley[2] (1895) gives 84 cases, all children, with 14 deaths; Mr. Pitts[3] gives two lists—86 cases, at all ages (St. Thomas's Hospital, 1880-1892), with 20 deaths—and 214 cases at Great Ormond Street during the same period, with 39 deaths. It is the complications of the disease that drive its death-rate up still to 15 or 20 per cent.; were it not for these, one might reckon it at 10 or 12 per cent.

Age must be taken into account. Of Hofmokl's 60 cases, 25 were under ten years old, and 23 between twenty-one and forty years old. If we take children only, we see that the youngest are in most danger of death: thus, of 54 fatal cases at Great Ormond Street, 6 were under one year old; 17, between one and two; 11, between two and three; 8, between three and four; 6, between four and five; 3, between five and six; 3, above six; and Dr. Coutts[4] has recorded 43 cases of empyema in children under two years old, with 27 deaths, a mortality of 63 per cent.

Sex need not be taken into account; the disproportion is no greater than we should expect from the more constant exposure of men to the chances of pleurisy and pneumonia, and is not found among children. Of Hofmokl's 60 cases, of all ages, 42 were male, and 18 were female.

---

[1] "Lancet," Dec. 21, 1895.
[2] "Lancet," Feb. 2, 1895.
[3] "Lancet," Oct. 14, 1893.
[4] "Lancet," April 13, 1895.

There is reason to believe that an empyema of the right side is more favourable than an empyema of the left side. The two sides are about equally susceptible: of Hofmokl's 60 cases, 26 were right, 33 were left, and 1 was double: of the 54 Great Ormond Street cases, 24 were right, 28 left, and 2 were double. It seems natural that the relation of the heart to the left pleura should make a left empyema more hazardous to the patient, and more embarrassing to the surgeon, than a right empyema. Dr. Marshall observes that six of his seven deaths occurred from left empyema. 'This is very interesting, and confirms the belief held by some that left-sided pleuro-pneumonia is always more dangerous to life than when it occurs on the right side.' And Hofmokl says, 'Left effusions need more care in puncturing than right effusions, partly because the pericardium has a larger share in the affection of the pleura, and the heart is more exposed to pressure; partly because there is greater risk of the great vessels being stretched, or even twisted or compressed, and thus giving rise to disturbance of the circulation and respiration. I have often noted that from a left effusion, even a very large one, you cannot draw off so much fluid as from a right one of the same size, and the patient is more likely, as the fluid is withdrawn, to get attacks of faintness, dyspnœa, restlessness, and dragging pain at the heart.'

Simple contusions may cause pleural effusions which may become purulent; but there are only one or two doubtful cases to support the belief that any such effusion can be purulent from the beginning. Penetrating wounds of the chest may lead to empyema after a sero-fibrinous effusion, or the blood effused into the pleura may break down, and empyema may thus be added to hæmothorax; but acute primary suppuration of the pleura after a pene-

trating wound is very rare, and even if it does occur, there is a period of some days before the bruised and bleeding tissues settle down to suppurate. The best way to estimate the probability of empyema, and the period of its onset, after a penetrating wound, is to take Schede's cases (see pages 214—221); they are of great value in teaching the behaviour of effusions after knife or bullet wounds, their uncertainty and complexity. These 19 cases in the continuous practice of one surgeon give the whole picture of the chances and irregularities of empyema after injury. His comment on them is as follows:—'In penetrating wounds of the chest, you have to deal with a small, insufficient opening, usually ill-placed for drainage, and with an effusion which is hardly ever pure pus, but almost always fœtid, sero-purulent, hæmorrhagic. Out of my 19 cases, 5 suppurated; 3 out of 11 knife wounds, and 2 out of 8 gunshot wounds. And of all nineteen, only one died.' We cannot too carefully study the work of a surgeon whose results are so excellent.

Or the wound may be inflicted during a deep operation on the neck or on the axilla, and if the operation-wound be or become infected, the pleura may suffer with it.

A man,[1] aged 39, had a large lympho-sarcoma of the right axilla, and during operation the pleura was punctured. Fever, exhaustion, profuse discharge of blood-stained serum, and emphysema of the neck and chest followed the operation, and he died on the third day. *Post mortem*, the axillary wound contained a few drachms of thin pus, and was covered with a layer of ashen lymph. The pleura was punctured in the third space, and was all covered with lymph, and contained two or three ounces of blood-stained fluid; so did the pericardium. Cocci, streptococci, and bacilli, were found in the axillary wound, and vast quantities of streptococci in the pleura.

[1] For reference, see Lockwood, on "Traumatic Infection," 1895, p. 23.

A TABULAR STATEMENT OF SCHEDE'S CASES OF KNIFE
ESPECIAL REFERENCE TO THE CHANCES

No.	Sex and Age.	Character of Wound.	Treatment.	Character of Effusion.
1	M. 38	Stabbed in 2nd left space. Hæmo-pneumothorax.	Wound simply disinfected and sutured.	——
2	M. 28	Penetrating stab, left side of chest.	——	——
3	M. 23	Penetrating wound in the back. Emphysema and pneumothorax.	——	——
4	F. 18	Several knife-wounds left side of chest. Hæmo-pneumothorax.	——	Blood and air.
5	M. 22	Stabbed in 4th right space. Hæmothorax. Dulness up to middle of scapula.	Wound sutured; no drainage; ten days later, puncture.	Altered blood.
6	M. 29	Large punctured and incised wound of back, to right of spinous processes of 5th to 8th dorsal vertebræ. Hæmothorax.	Aspiration a week after injury.	Fluid blood.
7	M. 26	Stabbed obliquely in 3rd right space, nipple line. Hæmopneumothorax.	Exploratory puncture, soon after injury. Wound disinfected and drained.	Pure blood.
8	M. 20	Stabbed in 3rd left space, nipple line. Broad wound, venous blood flowing freely from it; patient much collapsed. Complete hæmothorax.	Wound dilated; a large vein found wounded. Disinfection, plugging. Next day, counter-opening 8th space.	Pure blood.

WOUNDS AND BULLET WOUNDS OF THE CHEST: WITH OF INTRA-PLEURAL SUPPURATION.

Result.	Remarks.
Complete absorption of air and blood. Complete recovery in three weeks.	——
Discharged in nine days.	——
Wound healed in twelve days. Discharged four days later.	At time of discharge, there was still some dulness over chest, from spine of scapula downward.
No further trouble. Discharged in a month.	——
Some shrinking of the effusion was observed a few days after the injury. Recovered in a month.	The puncture let out 7 oz. blackish blood.
Complete absorption. Discharged about a month after injury.	No evidence, at first, that pleura was wounded. Next day, dyspnœa. Dulness reached to angle of scapula. 15 oz. fluid blood drawn off.
Drain left out on third day. Complete recovery; discharged in a month.	Dulness reached to angle of scapula; breath-sounds lost; great dyspnœa. Puncture let out pure blood.
Drain (which had been passed right through from wound to counter-opening) was left out on twelfth day. Complete recovery; discharged in two months.	——

A TABULAR STATEMENT OF SCHEDE'S CASES OF KNIFE

No.	Sex and Age.	Character of Wound.	Treatment.	Character of Effusion.
9	M. 24	A fortnight previous stabbed in 2nd left space, close to sternum. Now, in the region of the scar, a pulsating swelling, size of hen's egg; and other signs of left empyema.	Exploratory puncture in 7th space found blood-stained pus. Incision of pulsating swelling let out gas, and a stream of dark blood. Puncture in 8th space behind posterior axillary line let out more than a pint of broken-down fœtid blood. Irrigation. Next day, resection of 10th rib, posterior axillary line.	Resection let out large quantities of very fœtid, dark fluid, with large masses of fibrin.
10	M. 25	Contused, lacerated wound in 9th right space, anterior axillary line, freely admitting finger into pleura; pneumothorax; traumatic emphysema. Later, more than one circumscribed empyema.	At first, simple irrigation and drainage of wound. Three weeks later, resection of 5th rib, anterior axillary line. Six months later, resection of rib again.	At first operation, puncture close to wound found only frothy blood, but puncture of 4th space found thin, greenish pus, about ½ pint.
11	M. 29	Stabbed through 2nd left costal cartilage, close to sternum. Patient blanched; marked dyspnœa.	Counter-opening in 9th space; drainage right through.	3 oz. blood let out.
12	M. 36	Shot in 4th left space, nipple line. Bullet extracted from back. Hæmothorax; signs of pericardial effusion.	Puncture a week after injury gave pure blood, breaking down.	Blood.

WOUNDS AND BULLET WOUNDS OF THE CHEST—*Continued.*

RESULT.	REMARKS.
Discharged at own request, three months after operation, with a fistula. General condition very good; lung expanded; some deformity of chest wall.	The blood flowed so freely when the swelling was incised, that the surgeon, thinking a large vein was opened, plugged the incision, and sutured the skin over it.
Completely healed a month after second operation; lung well expanded.	Second operation found two large empyema cavities, with viscid pus.
A week later, he had delirium tremens, and died suddenly, nine days after the operation.	*Post mortem*, still much bloody fluid in pleura. Pericardium was thick and rough, and contained a quantity of blood clot. Blood-stained serum in left pleura.
Recovery; slight dulness; general condition good.	There was at first increase of cardiac dulness, and pericardial friction-sounds, with loss of heart-sounds. Ten days after injury, slight hæmoptysis.

[illegible] TABULAR STATEMENT OF SUMMARY OF CASES OF LAPSE

No.	Section Act	Character of Work	Treatment	Character of Lapses
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

A TABULAR STATEMENT OF SCHEDE'S CASES OF KNIFE

No.	Sex and Age.	Character of Wound.	Treatment.	Character of Effusion.
17	M. 24	Five months ago, shot close to right nipple: then empyema; incision 8th space, irrigation, and drainage. On leaving out drain, genl. health began to fail, and empyema filled again.	Incision of scar of previous operation, irrigation, and drainage.	1¾ pints of pus let out.
18	M. 23	Shot himself over the heart, splintering the 5th rib, and driving it into the lung. Severe hæmorrhage, then empyema; general condition very bad.	On sixth day, resection 9th rib, posterior axillary line, free incision of pleura, double drain, irrigation.	Fœtid pus and blood-clots.
19	M. 24	Shot himself in 5th left space, just over apex of heart. During next few days, great dyspnœa, high fever, intense pain and pleural effusion. On third day, dry tongue, delirium; temperature 104·3.	Puncture gave fœtid, bloody, sero-purulent fluid. Resection 10th rib, irrigation: T tube.	Great quantity of dark, fœtid fluid, with breaking-down blood-clots.

Apart from injury, it is doubtful whether there is any such condition as true primary empyema,[1] nor does the question concern surgeons. As to the usual causes

[1] The two conditions that may suggest it are those described by Bouveret, under the titles of "Pleurésie d'emblée suppurative," and "Pleurésie suraiguë de Fraentzel," but it is hardly possible to prove that these cases are not instances of very acute sero-fibrinous effusions, so rapidly becoming purulent that they appear to have been purulent from the beginning.

WOUNDS AND BULLET WOUNDS OF THE CHEST—*Continued.*

RESULT.	REMARKS.
Perfect recovery within a month; almost complete expansion of lung.	———
Repeated attacks of fever, repeated removals of fragments of bone or of clothing; repeated blocking of the drainage by granulation tissue. Complete recovery in two months.	The blocking of the drainage was obviated by using a T tube, without lateral openings.
Rapid recovery in fortnight, with complete expansion of lung. Drain left out on sixth day.	There was every reason to fear the heart had been injured, but no sign of it.

of empyema, it is hard to estimate their frequency. Hofmokl's 60 cases gives 37 of empyema after pleuro-pneumonia or sero-fibrinous pleurisy, without any signs of phthisis; 12 of empyema of tubercular origin, including 1 of empyema from tubercular caries of a rib; 7 from one of the specific fevers (4 measles, 3 scarlet fever); 2 from peritonitis; and 1 each from penetrating wound, gangrene of the lung, and sarcoma of the pleura.

Of König's 76 cases, 61, or eighty per cent. were acute non-tuberculous empyema; and it has been said that infection by the pneumococcus gives twenty-five per cent. of the empyemata of adult life, and fifty per cent. of those of childhood. As to the relations between tubercular phthisis and pleural effusions, M. Moutard-Martin (1882) found only 7 cases of tubercular disease in 84 cases of empyema; and M. Leudet, in 826 *post mortem* examinations of cases of phthisis, found pleural effusions in 100 instances; but of these 100 effusions, only 9 were purulent; 5 were limited to a part of the pleura, 4 occupied the whole of it. The effusion in tubercular phthisis is more often plastic or serous than purulent; and we must distinguish empyema due to tubercular phthisis from empyema due to tubercular ulceration of the pleura. Finally, as to the conversion of any serous effusion into an empyema, we must remember that every chronic serous effusion tends to become, sooner or later, purulent: in 162 cases of 'chronic pleurisy' the effusion was purulent in 101.[1]

Empyema Left Without Treatment.

The symptoms and physical signs of empyema in its earlier stages do not belong to a book on surgery; we may therefore leave them, and consider what is likely to happen to a patient suffering empyema, if his disease is left to itself. We are bound to admit the possibility of a natural cure or arrest of the disease. A small collection of pus may become shut off by adhesions, and may lie for years in a capsule of very thick, tough, fibrous tissue, as hard as cartilage, till it becomes dry and caked (see *Plate* V., *Figs. A* and *B*); such cases have been

[1] Krause, quoted by Bouveret, *loc. cit.*, p. 378.

PLATE V.

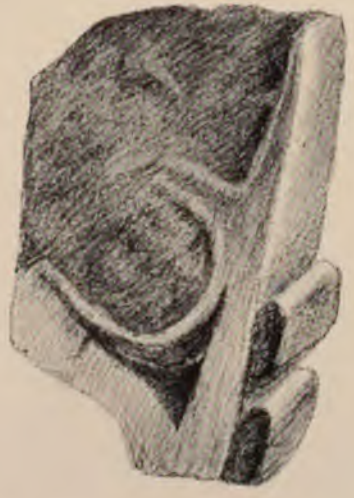


Fig. A.—Extreme Thickening of Pleura, with formation of a small circumscribed cavity at its lowest point. (From a specimen in St. Bartholomew's Hospital Museum.)

Fig. B.—Extreme Thickening of Pleura, with formation of a small circumscribed Empyema. (From a specimen in St.

recorded from time to time, mostly in children, in empyema after pneumonia; but even if they were more numerous than they are, they would not alter the duty of the surgeon to treat all cases of empyema without delay. Left to itself, it will kill the patient either by compression of the lung and heart, pericarditis, peritonitis, cerebral abscess, or septicæmia; or, if he escape death, he has again to face the danger of it when the empyema breaks through the pleura.

The pointing of an empyema beneath the skin, the old 'empyema necessitatis,' is now happily not often seen. I have had three cases. One was in a man with rapid tubercular phthisis; one, in a boy, had been diagnosed before admission to Hospital as a simple abscess; one, in a child, had been allowed to burst before he came under my care. In the first and second cases, the empyema, as it usually does, pointed over the lower ribs about the nipple-line: in the child, it had burst about the second and third ribs, near the sternum. The pointing of an empyema outward is marked by pain, tenderness, and œdema; and œdema is often present over an empyema long before it has pointed; but we must not take an œdema that is extended far over the chest as a positive sign that an effusion is purulent; a serous pleurisy may cause it.[1] A localised patch of œdema is strong evidence that we have to deal with an empyema. When the empyema has pointed, if the communication between the deep and the subcutaneous collections of pus be narrow or sinuous, the subcutaneous abscess may well be mistaken, as in my second case, for a 'simple abscess'; even after laying it open, I could not find the way into the

[1] Warburton Begbie (Syd. Soc. 1882) gives reference to four cases of firm œdema of the lower limb in cases of serous effusion into the pleura.

pleura, and had to go on with the ordinary operation for empyema. But if the communication be wide, the superficial abscess may transmit the movements of respiration, or the impulses of the heart, or both. In pulsating pointing empyema,[1] the cardiac impulse is synchronous with the ventricular systole; it is distinctly expansive; the effusion is always on the left side, always large, and usually chronic; the heart is always displaced, and usually fixed in its displacement. But we must note that an effusion may pulsate long before it points; there is an intra-thoracic pulsating effusion, as well as a pointing, pulsating empyema; and, in two or three instances of intra-thoracic pulsation, the effusion was sero-fibrinous, not purulent; the pulsating effusions that pointed were, of course, all purulent—for it is just the purulent softening of the tissues that enables an empyema to point. M. Comby has collected 27 cases of pulsating effusions: ten or twelve of these were intra-thoracic—all on the left side—the rest were pointing empyemata. In the intrathoracic effusion, the pulsation is usually limited over two or three spaces, and usually, but not always, toward the front of the chest; but Stokes had a case of a huge left empyema, with great displacement and fixation of the heart, where a most violent pulsation was observed over the whole side of the chest, so that the bed was shaken, and the patient disturbed from sleep by it.

As regards pulsating pointing empyema, out of 11 cases collected by Müller, 10 were on the left side (7 single, 3 double), and 1 was on the right side. In three

[1] The whole subject of pulsation of pleural effusions is discussed at great length by Bouveret, and by Comby, "Thèse de Paris," 1881. See also Wilson, quoted in "Wien. Med. Wchnschr.," 1893, p. 476. The first accounts of pulsating empyema we owe to Irish physicians, McDonnell (1844), Stokes (1864), and Walshe (1870).

cases, the swelling registered not only the movements of the heart, but also those of respiration, falling in inspiration, rising in expiration. In two, the tension of the swelling varied more or less with the posture of the patient. Its pulsation is less forcible than that of an aneurysm in the same position would be. A vascular malignant growth within the chest may pulsate; and a rare form of pneumonia has been described, with pulsation of the lung; for these reasons one must be careful to make a right diagnosis. For the explanation of pulsation in a pleural effusion, many fanciful reasons have been given—a combination of pericarditis, or of pneumothorax, with the effusion, a layer of collapsed lung between the heart and the effusion—but it is still hard to see why some effusions should pulsate, and not all.

Pointing empyema will, we may hope, be less common now than it was in former years. We get the Hospital cases at an earlier stage, and we operate without delay. In 1873-76, out of 12 cases of empyema that came under the care of Settegast, 6 had already been suffered to burst outward: we cannot wonder that the mortality of the 12 cases was 50 per cent. Out of Hofmokl's 60 cases, the empyema was pointing in 7, but had not yet burst. I have had three pointing empyemata—one of which had burst; two recovered, in the third the empyema healed, but the patient died of acute phthisis.

Empyema breaking into the lung, according to Fräntzel (1875), is more common than empyema breaking outward; and Pel (1890) says the same. Both these disasters will become less common in proportion as our Hospital patients, or their parents, become less neglectful of the early stages of disease, and in proportion as the early diagnosis and treatment of empyema become

universal. It is said that the form of empyema most likely to break into the lung is a small, circumscribed effusion, after pneumonia, in a young patient. The method of invasion of the lung varies from a very gradual leakage to a sudden swamping of the bronchi; and it is to be noted that the passage of the pus into the lung is not likely to be followed by the passage of air from the lung into the pleura; either there are adhesions at the point of communication, or the lung tissue is soaked like a sponge with the pus, and this saturation of the patch of lung round the opening is increased by the patient's coughing, so that the small bronchi are compressed. It would be easy to quote a number of cases of the escape of an empyema into the lungs, but they differ so widely in their clinical features, that they give no rule of practice, except the plain warning that an earlier operation might have prevented it altogether. In most of them, the patient recovered. Moore, of Dublin,[1] even records two cases of 'putrid empyema,' where recovery thus occurred. In other cases, the lung was invaded even after operation.

The following two cases offer some special points of interest:—

1. A boy, aged 9, after pneumonia, was found to have a small circumscribed empyema of the right side. On aspiration, four ounces of healthy pus were drawn off; but on several subsequent occasions, repeated attempts failed to find any pus. Between eight and nine weeks after admission to Hospital, he was seized with a violent fit of coughing, and coughed up nearly a pint of pus, followed, a few hours later, by pus mixed with mucus. He made a rapid recovery.

2. A man, aged 64, after pneumonia, showed signs of empyema, and on aspiration, thin, blood-stained, intensely

[1] Cases of Pleurisy with Fœtid Effusion, simulating Gangrene. "Dublin Quarterly Journal," xxxix., 279. But it is not improbable that these were cases of gangrene of the lung.

fœtid pus was drawn off. He was suffering from septic absorption—high fever, very rapid pulse, dry tongue—but he resolutely refused operation. A few days later, he coughed up a great quantity of pus, and finally made a complete recovery.

But there are many other ways along which an empyema may pass beyond its natural limits, when once it has escaped from the pleura. In one or two cases only has it broken into the œsophagus, or into the pericardium; and it very seldom breaks through the more central part of the diaphragm. More often, it makes its passage past the attachments or the crura of the diaphragm, and may thus point in the lumbar region, the gluteal region, or somewhere in the anterior abdominal wall; or it may enter the sheath of the psoas muscle, and follow the course of a psoas abscess. These wanderings of empyema, '*migrations insolites*,' are more common in empyema of the left side, and in young people; and the abscesses that they cause may move with respiration, or may pulsate with the heart.

1. A man, aged 38, was under my care some years ago, with empyema of the lower portion of the left side, after pneumonia. At the first operation, no pus was found, but during it he coughed up one or two drachms of pus. A few days later, the empyema was opened and drained. He did well, and three weeks after the operation was allowed to leave his bed: that same day, he had a rise of temperature, and after this he was feverish, and began to lose ground. About a week later, he began to complain of great pain down the thigh, and kept his leg drawn up. Four days later, he also had pain at the back of the thigh, below the gluteal muscles; there was diffuse, tense, painful swelling in Scarpa's triangle, and an incision here, about an inch below Poupart's ligament, let out six or seven ounces of pus. I found a huge abscess cavity, passing up out of reach through a broad opening beneath Poupart's ligament, and also tracking round the inner aspect of the femur to the back of the thigh,

rendering necessary a counter-opening. He made a complete recovery.

2. A girl, aged 14, with scars of tubercular caries, was admitted to Hospital (1877) with a left pleural effusion, which was allowed to go for many weeks without active treatment. Eight weeks after admission, she complained of pain about the left hip joint, and here a huge abscess was found, six inches by nine, occupying the upper part of the ilium and the gluteal region. It was punctured, and several ounces of pus were let out; it was now observed that the breath-sounds were more clearly heard over the affected side. Two days later, it was again punctured, and thirteen ounces of pus were let out. 'The percussion note returned over the chest, the breath-sounds were heard everywhere, the ægophony disappeared.' The child was taken away from hospital, and the end of the case is not known.

3. A woman, aged 40, suffering with tubercular phthisis, and with effusion of pus and of air (pyo-pneumothorax) in the right pleura, had in the right lumbar region a fluctuating reducible swelling. It refilled after puncture and evacuation, and plainly contained both air and fluid. Nothing more was done on account of the state of her lungs, and she died a few weeks later. *Post mortem*, the pleura was found emptied of effusion, the lung was collapsed to a mere remnant; a fistulous track, burrowing among the muscles in the loin, united the cavity in the loin with the lowest level of the pleura.

4. A woman, aged 22, five days after confinement, had acute pleurisy of the left side, with rapid effusion. In a week the effusion had sunk to one-half of its former level; at the same time, in that side of the abdomen, there appeared a large, firm, rounded, tender swelling, overlying the kidney, limited below by the sigmoid flexure pushed downward and inward, and filling nearly the whole of the left side of the abdomen: its area of dulness was continuous with that of the spleen. Pus was drawn off from it by an exploratory puncture: not offensive, containing no renal epithelium or casts, a few staphylococci, no tubercle bacilli, and yielding an abundance of crystals of tyrosin when it was dried. The swelling was incised, and about a pint and a half of pus was let out. Next day, there was also a free evacuation of pus *per rectum*. The patient did well.

These four cases may serve to show some of the courses and characters of migrating empyema. Many

others, and full consideration of each group of them, will be found in Bouveret's great work on empyema.

I have in this chapter taken only a few of the many questions that centre round empyema; questions of diagnosis have been left untouched, and many other matters regarding it. I have attempted only to note some few facts that are rather surgical than medical, and concerned less with diagnosis than with operation.

CHAPTER XVI.

THE OPERATION FOR EMPYEMA.

THE treatment of empyema is a very wide subject, and there are three conditions attached to it. The cavity must be thoroughly emptied and drained; the pleura must be protected from further infection; and the lung must be left free to expand. The old routine treatment by repeated punctures or aspirations has, happily, gone for ever. As a general method, it was full of faults; but here and there, by a sort of chance, it was successful. It might cure a small recent circumscribed post-pneumonic empyema in a child, a thin-walled cavity containing a few ounces of pus, behind ribs not yet rigid; such cases did happen now and again. It had, and still has, a narrow field of usefulness, in some cases of advanced phthisis, or pyæmia, or in very old and enfeebled patients, or in malignant disease, as a temporary or palliative measure: and that is the most that can be said for it.

Nor need we consider the early attempts to combine drainage and irrigation with puncture; there was no efficiency in the combination of three inefficient methods; one cannot irrigate the pleura through an aspirating-needle, or drain it with a narrow tube passed down the cannula of the trochar after puncture; the lotion stays in, the pus does not come out, the tube gets blocked, a fresh puncture is made, also in vain, and so the whole thing fails. But one method must be mentioned here, not because it is in itself very valuable, but because the controversy raised about it in Germany illustrates

the whole subject of the treatment of empyema: and that is Bulau's permanent syphon-drainage by means of a long rubber tube having one end in the empyema, and the other, at a lower level, in some antiseptic solution. The especial claim made on its behalf is that it alone of all methods both keeps out the air, and also tends directly to promote expansion of the lung by a steady process of suction. I have put in an Appendix Dr. Bulau's account of this method, and added, in the form of a debate, what has been said for and against it by other surgeons. But whoever will read it carefully will agree with the majority, that it is to be kept for exceptional cases, and is tedious, uncertain, incomplete, and not wholly free from danger. We need not consider the methods which, more or less, resemble it, but may go on to the present operation for empyema.

(1,) *The Exploratory Puncture.*—As one should always sound a patient with stone in the bladder immediately before operation, so one should make an exploratory puncture immediately before operation on an empyema; and not omit this safeguard because pus was found on puncture a day or two previously. One must use a proper exploring syringe, with a long steel needle; the old 'grooved needle,' though its evil habit of leaving a drop of pus behind it can do no harm when a free incision is at once made along the track of it,[1] is an instrument that should be allowed to remain in oblivion; it has done great harm, and has fallen into disuse altogether. Even with the exploring syringe, puncture

[1] 'I have frequently seen simple puncture of an empyema followed by phlegmonous inflammation along the track of the needle, even though every precaution was taken in the use of antiseptics; and more than once, in cases of tuberculous patients with fœtid pyo-pneumothorax, I have seen puncture followed by extensive fœtid abscess, with gangrene of the skin.'—*Hofmokl.*

through a thick layer of muscle should, if possible, be avoided; in one of my cases, where the signs of effusion were most marked over the front of the chest, puncture with an exploring needle through the pectoral muscle was followed by a small abscess beneath it. Of course, the skin must be carefully cleansed before puncture, and either ethyl-chloride or cocain should be used; either a strong solution of cocain, 20 per cent., painted on the skin, or a weak one, 2½ per cent., injected under it; or, better still, first paint the skin, then put the cocain under it. The needle of the syringe should be steadied and guarded so as not to go too far, and should not be thrust forward with a jerk, but guided over the upper edge of the rib. Before withdrawing it, one must be careful to leave off drawing on the piston. And even if one fails to find fluid, there may be a minute drop of it in the needle, enough for the microscope. In a case of malignant disease of the lung simulating pleural effusion, one may find a shred of the growth in the needle. The contents of the needle, therefore, must be carefully examined with the microscope, even if it be only the smallest drop of fluid or shred of tissue.

(2,) *The Anæsthetic, and the Position of the Patient.*—In dealing with a large empyema, it is very important—especially if it be on the left side—not to turn the patient far over on to the sound side, lest the action of the sound lung, or of the heart, should be affected. Some years ago, a boy, aged 10, was admitted to Hospital with total empyema of the left side, distension of the intercostal spaces, displacement of the heart, and general condition very serious. He was at once taken to the theatre, and chloroform was very carefully administered. He was turned a little way over on to his other side, without any harm resulting; then, after waiting and

watching him, I turned him over a little further, and made my incision. At this moment, he stopped breathing, but his pulse went on, and the anæsthetist did not at once notify the cessation of the breathing. Then the pulse stopped, and neither by letting out the pus, nor by artificial respiration, were we able to restore life. The giving of an anæsthetic we can hardly avoid; but we must not keep the patient without food for many hours before the operation, and we may do well to give him some brandy immediately before it. I believe that with these precautions, and with the patient not turned far over, the anæsthetic itself is free from any special risk; and of all the cases collected by Mr. Pitts, only one died during the operation.

3. *Incision and Resection.*—If the effusion be complete and not limited by adhesions, the incision should be made over the eighth space, or the ninth rib, just outside the angle of the scapula[1]. If it be small, partial, circumscribed, the operation must follow the guidance of the exploring syringe. It is of great importance that the incision should be free, and that every layer should be cleanly and thoroughly divided, so that a good inch of rib is clearly exposed. There is no need to be careful to keep the periosteum of the rib, indeed 'subperiosteal resection' is a mistake; one has only to free the rib all

[1] 'In a complete empyema, no position is better—none, indeed, is so good—as that opposite the ninth rib, just outside the angle of the scapula. (1,) It is just above the level to which the diaphragm becomes adherent to the ribs when it has been drawn up as much as possible; (2,) It is, therefore, very soon, if not at first, one of the most dependent parts of the pleural cavity when the patient is standing up, and it is always the most dependent part when he is lying on his back; (3,) I practically find that this is a much more advantageous position.' Godlee, Brit. Med. Ass. Meeting at Nottingham. "Brit. Med. Journ.," 1892, ii., 828.

round, isolate it, and divide it with very large strong forceps; but one may first groove it with a saw, if it be so thick that the forceps alone might splinter it. The Hippocratic method of trephining the rib, so as to avoid the intercostal vessels, has lately been revived by Rey in Italy[1]; but it is wholly unsuited for the treatment of empyema.

Incision without resection is, at present, out of favour, and the removal of an inch of rib has come to be almost an integral part of the operation. Yet Rosenbach[2] has lately recorded a series of 15 cases of empyema, of all kinds, and in patients of all ages, treated by incision without resection, every one of them successful; and it is quite possible that this method may be again revived. Foltanek advocates it for empyema in childhood, as giving a smaller wound and an easier operation. Of Hofmokl's 60 cases, 18 were thus treated. I have done it several times, and it has always answered well; in one case, 105 ounces of pus, with fibrin, were let out, and the patient recovered very quickly. It is true that the reasons brought against resection are of very small value, and it gives the surgeon command over masses of fibrin, which are often present in cases of complete empyema of some weeks' duration (see Schede's cases),[3] and it ensures ample room for drainage: still, there are cases where it is not necessary. We must take each case on its own merits; in most, we do well to resect; but it is not an essential part of the operation, and cases do, from time to time, occur where the surgeon had best content himself with a free incision, properly placed

[1] See "Brit. Med. Journ.," Sept. 21, 1895, and a case recorded by Surgeon-Captain Moffet, March 7, 1896.
[2] "Wien. Med. Presse," 1892, p. 515.
[3] See also Gläser (Appendix B).

and made, without resection. There are signs that the surgery of the chest is beginning to draw back a little over one or two operations—if such a phrase may be pardoned; and it is not improbable that in a few years we shall define, more accurately than now, those cases where resection is or is not necessary.

4. *Evacuation of the Empyema.*—Since the pleura may be greatly thickened, it must be opened with the point of the knife rather than with a director. Either the intercostal vessels are obliterated, or one avoids them by noting the impress of the resected rib on the pleura; anyhow, they do not offer any trouble during the operation. And the rule is as old as Hippocrates that the effusion must not be let out too rapidly, lest the patient should faint.

Two or three minor questions have to be considered. Ought the surgeon to explore the cavity with his finger, or to curette its walls, or to irrigate it? I have never learned much from exploring the cavity with my finger.[1] Bouveret advocates it for three reasons; you can ascertain the exact extent of the cavity, remove masses of fibrin, and break down the false membranes which sometimes are found dividing up an empyema into a system of abscesses (*empyème cloisonné*). But the exact extent of the empyema is not of much practical concern; the masses of fibrin will find their way out of the cavity without the surgeon's help; and the plan of breaking down adhesions of which one knows very little, and sees nothing, seems to me best avoided. And as regards

[1] A case showing the advantage of exploring the cavity with the finger is given in the chapter on Pericardial Effusions. Empyema and purulent pericarditis were both present together; and the surgeon, having opened the empyema, felt with his finger the distended pericardium, and opened it and drained it through the incision in the chest-wall.

interfering with the walls of the cavity, here again we may fall into the fault of officious surgery. 'I always wash the cavity out at once,' says Schede, 'and if that does not seem to be satisfactory, I rub its walls, and give them a good scraping with a Volckmann's spoon. It is very important to get the cavity disinfected once and for all, and I abhor subsequent irrigation.' But to scrape an ordinary empyema seems to me wholly unnecessary and undesirable. As regards irrigation at the time of operation (irrigation during after-treatment is considered in the next chapter), there are different opinions, some in favour, others against it. I believe one should avoid it, because the patient, being under the anæsthetic, cannot show, by coughing or by complaining of pain, that the irrigation ought at once to be stopped. I have given it up in ordinary cases; and I wholly disagree with the routine treatment that Dr. White and Dr. Wood[1] advise—'It has been our practice to irrigate the pleura until the fluid came away clear; no harm has seemed to us to follow this procedure.'

5. *Drainage, Dressing, and Posture in Bed.*—The perfect tube has at last been evolved from the innumerable varieties that have been used for empyema. Metal tubes might, and sometimes did, cause caries of a rib, or secondary hæmorrhage from an intercostal vessel. Long tubes might, and sometimes did, irritate the diaphragm, or get caught in adhesions, or kinked; all complicated arrangements—two tubes, side by side, or one inside the other, or a whole row of tubes like a Pan's pipe, or a tube brought out through a counter-opening—these also were bad. The perfect tube is a single, short, large, flanged rubber tube, without side holes, with a bore of $\frac{3}{8}$ to $\frac{5}{8}$ inch,

[1] The Treatment of Empyema, with Selected Cases, Detroit, 1894.

long enough to reach the cavity, without projecting far into it. The danger that a tube may slip or be drawn into the pleural cavity, will be considered in the next chapter; so will Wagner's method of loosely packing the cavity with gauze, in cases where drainage has failed.

The dressing is not the least important part of the operation. It must be of sufficient extent and thickness, soft, carefully fitted, covering the whole chest, including the arm on the affected side down to the elbow, accurately adjusted to the skin round its whole area. In the operation for empyema, there are at least three things the dressing must do. It must preserve the cavity from further infection; it must receive and distribute through itself a discharge which is sure to be profuse, and may come in a rush some hours after the operation; and it must act, to some extent, as a valve, so that the patient may rid himself by coughing of the air that has filled the cavity, without taking in a fresh supply at every inspiration.

The posture of the patient in bed after the operation is also important. I have given several cases of effusion of blood into the pleura which could be emptied out of the patient's chest, almost as one pours water out of a jug, by placing him in some special position: the same thing has been noted in a few cases of empyema; but chiefly, I think, in cases after gun-shot wound. König has a regular system of attitudes; for the first few days he keeps the patient on his side, turning him occasionally a little backward or forward. Then, he has him raised by an assistant four times daily, who lifts him by the pelvis, while the patient lies on the shoulder of the affected side; and in this position he is turned to and fro, so as to empty his chest as much as possible. Later, it will suffice if he puts his body over the side of the

bed, and supports himself with his outstretched hand on the floor. But to justify these gymnastics, we must note that König makes his incision higher than most surgeons, at the level of the fourth, fifth, or sixth rib. They belong, so far as they are at all valuable, to the after-treatment, not to the present chapter. But certainly one must be careful that the patient is put back to bed in a good position for drainage, and not by any neglect allowed to lie on his sound side.

To illustrate the whole course of empyema, and its treatment, I give Schede's cases, arranged in a table showing clearly those aspects of the disease and of the operation that are of most practical importance. It will be noted that on three occasions an operation of very great severity was practised; but I include these cases with the rest, on account of their general character; and

SCHEDE'S CASES OF OPERATION

No.	Sex and Age.	Character of Disease.	Operation.	Fluid Let Out.
1	M. 5	Acute left empyema, of enormous size.	Resection of tenth rib in posterior axillary line.	Nearly a quart of pus, with thick masses of fibrin.
2	M. 5	Acute right empyema, after pneumonia; dulness up to fourth rib.	Incision of sixth space in posterior axillary line.	Character of pus not stated.
3	M. 26	Acute left empyema, after pneumonia; dulness up to spine of scapula. T. 103.	Resection of ninth rib.	Large quantity of pus, with thick masses of fibrin.
4	M. 2½	Acute empyema, whole left side of chest, after scarlet fever.	Resection of eighth rib.	Thick pus, with flocculent shreds of fibrin.

will give, in the chapter on Chronic Empyema, examples of that 'thorax resection' which we especially associate with Schede. The notes of many of my own cases are so defective that I am compelled, for the sake of making this book as useful as possible, to give only such among them as may serve here and there to illustrate points of special interest.

Cases of double empyema must be treated by the rules already given: except for such preliminary aspiration as may enable the patient to avoid the shock of the two operations, which must not be done on the same day. A good instance of this condition, with many references, is given by Dr. Coupland and Mr. Pearce Gould, in the 'Transactions of the Clinical Society,' for 1891.

FOR EMPYEMA (up to 1890).

Result.	Remarks.
Complete recovery in nineteen days.	Lung fully expanded by fourth day. Tube left out on tenth day.
Operation, June 4th. Complete recovery end of August.	Drained for many weeks. Had, at same time, an abscess in the left thigh.
Complete recovery in six weeks.	Had been punctured a fortnight previously.
Complete recovery in ten weeks.	Lung expanded, but breath-sounds weak. Slight lateral curvature.

SCHEDE'S CASES OF OPERATION FOR

No.	Sex and Age.	Character of Disease.	Operation.	Fluid Let Out.
5	M. 18	Circumscribed bi-locular left empyema, with pneumonia.	Resection of ninth rib: later, of seventh and eighth, with resection of fourth rib for counter opening.	No mention of masses of fibrin.
6	F. 29	After pleurisy, gangrene of right lung, with total pyo-pneumothorax. Later, simple circumscribed left empyema.	Resection of eighth right rib, posterior axillary line. Later, syphon-drainage of left empyema.	Pus on right side fœtid.
7	M. 28	After pneumonia, gangrene of right lung, with enormous putrid empyema, which burst into a bronchus.	Free resection of ninth and tenth ribs, two large drainage tubes.	Nearly a quart of greyish black, intensely fœtid pus, with large pieces of gangrenous lung-tissue.
8	F. 35	After pneumonia, right empyema, which burrowed into right lumbar region.	Lumbar abscess incised. Later, resection of eleventh rib.	Character of pus not stated.
9	M. 24	After pneumonia, right empyema.	Resection of sixth rib, posterior axillary line. Later, a fistula remained, which was irrigated.	Character of pus not stated.
10	F. 20	After pneumonia of left lower lobe, circumscribed left empyema.	Resection tenth rib, posterior axillary line.	A large quantity of fœtid pus, with large masses of fibrin.
11	M. 31	Empyema.	Resection ninth and tenth ribs in posterior axillary line.	Large quantity of very fœtid pus.

EMPYEMA (up to 1890) – *Continued.*

RESULT.	REMARKS.
Complete recovery in ten weeks.	Had been previously incised in sixth space, anterior axillary line, and drained.
Complete recovery. Right side healed in two months, left side in three days.	A piece of gangrenous right lung was coughed up. Fluid syringed into right cavity came through mouth.
Complete recovery. Wound healed in two months.	Before operation, he used to cough two to four pints daily of fœtid pus. Repeated exploratory punctures before operation had failed to find pus: probably cannula was not long enough, as he was extraordinarily muscular.
Death three weeks after operation, from extensive ulceration of the colon.	Lung failed to expand, and was found *post mortem* packed against the spine.
Death three and a half months after operation, from multiple cerebral and cerebellar abscesses.	Injection of the fistula caused intense collapse, and was not repeated. *Post mortem*, tuberculous caseous foci in left upper lobe: pericardial adhesions.
Death within a fortnight, from multiple abscesses of right frontal and temporo-sphenoidal lobes.	Ulceration of the lower bowel. Purulent peritonitis, with effusion into Douglas's pouch.
On third and fourth days after operation, profuse hæmorrhages from the cavity.	Death on fifth day. *Post mortem*, several abscesses in the lung. Source of hæmorrhages not discovered.

SCHEDE'S CASES OF OPERATION FOR

No.	Sex and Age.	Character of Disease.	Operation.	Fluid Let Out.
12	M. 35	After pneumonia of right lung, gangrene with pyo-pneumothorax.	Resection eighth rib far back.	Large quantity of very fœtid pus, let out slowly.
13	F. 38	Small circumscribed empyema, with fistulous opening.	Resection seventh rib. Drainage of fistulous track.	——
14	M. 3	Fistula in third right intercostal space, large right empyema, chronic.	Resection eighth and ninth ribs, posterior axillary line.	About 8 ounces of thick greenish pus.
15	M. 23	Four years ago, right pneumonia, followed by pleural effusion. Lately, signs of pyo-pneumothorax.	Puncture sixth space, posterior axillary line.	Half a pint of viscid purulent fluid.
16	M. 63	Large left empyema, with abscess over seventh and eighth ribs.	Resection of seventh and eighth ribs, posterior axillary line. Cavity lightly packed with iodoform gauze.	Character of pus not stated.
17	M. 33	Circumscribed right empyema. For the last year, signs of phthisis.	Resection fourth rib in front.	Loculated cavity, extending far and wide, full of pus and fungous granulations.
18	M. 28	Advanced phthisis. In fifth left space, in axillary line, a fistula leading to a very large old empyema cavity.	Subperiosteal resection of all ribs from third to tenth, about 2½ inches of each.	——

EMPYEMA (up to 1890)—*Continued.*

RESULT.	REMARKS.
Death in a few minutes.	A drunkard. *Post mortem*, foci of gangrene in middle and lower lobes. Arterial sclerosis. Cardiac thrombosis.
Discharged with a short extra-pleural fistula.	Empyema had been incised three months before operation.
Taken home before complete healing.	Lung expanded well. Fistula healed after scraping and drainage.
Discharged at his own request; cavity partly obliterated.	Effusion had never wholly disappeared, in spite of punctures.
Healed in three months.	A year before, he had been treated for 'chronic abscess' below left nipple by resection of a small piece of seventh rib.
Discharged in two months much improved, with a small external fistula.	Dulness reached from sternum to axilla, and from second space to liver. Puncture at first failed to find pus, owing to great thickness of pleura.
Did well for a week; then began to sink, and died on sixteenth day after operation.	*Post mortem*, Advanced tuberculous phthisis; large cavities in left upper lobe. Tuberculous ulceration of larynx and of large intestine. Adherent pericardium. Thrombosis of right femoral and external iliac veins.

SCHEDE'S CASES OF OPERATION FO

No.	Sex and Age.	Character of Disease.	Operation.	Fluid Let Out.
19	M. 15	Circumscribed left empyema, pointing over seventh rib in front: of great size.	Resection of sixth and seventh ribs, at junction of bone and cartilage. Later, resection again of sixth and seventh, and later still, of fourth and fifth ribs. Cavity lightly packed with iodoform gauze.	Huge cavity with enor mously thick ened walls, an numerous loculi. Trace of lung tissu were found i anterior wall o cavity durin operation.
20	M. 22	After pleurisy, circumscribed right empyema, pointing over sixth to eighth ribs in nipple line.	Resection seventh rib. Later, cauterization of cavity.	Caseous pus fungous granu lations, bur rowing sinuse in soft tissues.
21	F. 16	Chronic left empyema, with fistula in sixth space, posterior axillary line. Advanced tuberculous disease of upper part of lung.	Resection of seventh to tenth ribs ($2\frac{1}{2}$ to 4 ins. each), irrigation, scraping, packing with iodoform gauze.	—

EMPYEMA (up to 1890)—*Continued.*

RESULT.	REMARKS.
Very slow recovery, great difficulty in getting cavity to heal; completely closed in seven months. Then he caught diphtheria, and died.	*Post mortem.* Empyema healed. Cavities in both lungs. Ulceration of larynx, probably tuberculous.
Cavity closed; smal external fistula.	Discharged at own request: some signs of phthisis at apices.
Excellent recovery; not only did empyema heal, but lung was greatly improved.	Empyema had pointed and been incised a year before operation: for some months after the incision she had been too ill for any further treatment: then she got better.

CHAPTER XVII.

AFTER THE OPERATION.

THE operation for empyema brings with it the possibility of fresh risks and difficulties, and these we may divide under four heads: 1. *The general condition of the patient.* 2. *The wound.* 3. *The cavity.* 4. *The drainage-tube.* A separate chapter will be necessary for those ultimate troubles of chronic fistulous empyema which may demand extensive resection.

THE GENERAL CONDITION OF THE PATIENT.

The risks of death after operation, from the general condition of the patient, apart from the special risks of his disease, are many and grave. The shock of the operation is, as a rule, somewhat severe[1]; or the case may be one of gangrenous empyema, and the patient may be already under sentence of death from acute septicæmia.[2]

A man, aged 25, waiter at a restaurant, said to be given to drink, and to have had an attack of delirium tremens, came under my care, having been ill a fortnight with 'pleurisy.' He was delirious, half comatose, feeble, plucking at the bed-clothes, passing everything under him; tongue hard and dry, and foul with thick black crusts; temp. 101–102°; urine

---

[1] In one of my cases, a young man, aged 20, the pulse during operation shot up rapidly to 160, and then wholly failed for a few moments, and he was for a short time in great danger.

[2] There is an admirable article on this form of empyema by Dr. Alexander James, in the "Transactions of the Medico-Chirurgical Society of Edinburgh," 1890-91.

albuminous; signs of circumscribed effusion, left side of chest. An exploratory puncture drew off thin purulent fluid, intensely fœtid. Free incision, without resection, through the sixth space, in the posterior axillary line, let out more than a pint of thin greyish-black purulent fluid, horribly fœtid. I put in a very large tube. Next day he was no better: sleepless, delirious, comatose; the cavity was still fœtid, and I washed it out with warm boracic lotion; the exposed edge of the trapezius was ashen-grey and sloughy. He lived six days longer; never regained consciousness, passed everything under him, had to be fed through the nose; pulse became intermittent, diarrhœa set in, chest ceased to move in respiration; he became day by day weaker, and sank and died without ever becoming conscious. His temperature came down to normal four days after the operation, but ran up before death to 106°. The cavity, by repeated irrigation, became perfectly sweet and dry soon after the operation, and so remained till death. A large gangrenous abscess came under the trapezius, and another below and in front of my wound; these were duly opened and drained. The *post mortem* examination showed a dry empty clean cavity, perfectly drained and disinfected; a collapsed, shrunken, airless lung, one-third its proper size, bound down and packed away against the spine.

Here was a case where the patient had even before operation absorbed so much poison that he never roused from his typhoidal state.

The other grave risks, arising from the general condition of the patient, that may spoil the success of the operation, we may best estimate by taking the published results obtained by different surgeons. Eddison, of Leeds,[1] out of 31 cases of empyema treated by a strictly antiseptic method, lost six: three from tubercular phthisis; one immediately after operation, from old cardiac and renal disease; one, a drunkard, on the third day, with collapse of the lung; and one, on the fifth day, from 'coalminer's phthisis.' König, out of 76 cases (1891)

[1] "Brit. Med. Journ.," Sept. 29th, 1883.

lost ten: two from tubercular phthisis, four from 'multiple abscesses,' four from 'other grave complications.' Hofmokl (1889), less fortunate, lost 28 cases out of 60[1]: of these, 13 died of tubercular disease either in the lungs or elsewhere; 6 of pneumonia; 3 of purulent pericarditis and myocarditis; 3 of peritonitis; one each of amyloid disease and shock, paralysis of the heart, and malignant disease. I have had 3 deaths: two have already been recorded, the third was from tubercular phthisis a few weeks after the empyema had healed. It is to be noted that the ways of death after the operation for empyema, so far as the general condition of the patient is concerned, come either from acute septicæmia or pyæmia, from amyloid disease, or from organic disease.

Of the acute septic processes that may follow empyema, before or after operation, true pyæmia is rare indeed,[2] and we need not fear the possibility of it. Acute septicæmia, in the days before Lister, was terribly common; the discharge from the cavity becomes thin, greyish, perhaps hæmorrhagic or fœtid; the wound becomes indolent, pale, and sloughy; fever, diarrhœa, delirium, and prostration mark the beginning of the end. We may hope that such a way of death is now closed, save for cases of gangrenous empyema; the danger of 'pleural septicæmia' arises almost wholly from imperfect drainage and wrong methods of surgery.

Among the septic processes that may follow empyema we must also reckon the formation of abscesses in the lung, as in one of Schede's list of cases; and that most strange connection between empyema and cerebral

---

[1] Hofmokl's 60 cases of 'major operations on the thorax' include one or two that were not empyema.

[2] 'I have only in one case met with metastatic abscesses elsewhere than in the brain.' Godlee, 1892.

abscess. Sir William Gull[1] first called attention to the fact that cerebral abscess is common after suppuration within the chest: Schede records two cases after empyema; Mr. Godlee (1892) records five, and points out that abscess of the brain does not necessarily follow soon after an operation on the ribs, and moreover may be quite independent of surgical interference; that one side of the brain is not more often affected than the other, nor one part of it more than another. Similar cases have been recorded by Dr. West and Dr. Finlay. This curious affinity between the brain and the thoracic organs is an instance how relations between remote organs, unknown in health, may be made manifest by disease. It cannot be explained by any theory of mechanical disturbance of the cerebral circulation, nor by any general reference to septic embolism; nor is it a matter of chance. One thing is certain, that the localization of pyæmic abscesses does not take place in a purely haphazard fashion. Some years ago[2] I tabulated the distribution of the abscesses in nearly 200 cases of pyæmia, and found evidence that in pyæmia, as in malignant disease, though the elements of the disease may be disseminated over the whole body, they grow better on some soils than on others.

Amyloid disease we only know in cases of chronic fistulous empyema; and the examples in general surgery of recovery from this disease, after the cause has been

[1] "Guy's Hospital Reports," 1857. For references to more recent records and opinions, see "Clinical Society's Proceedings," Jan. 25th, 1884, and "Medical Society's Proceedings," Feb. 8th, 1886.

[2] "Distribution of Pyæmic Abscesses," "Lancet," 1886; "Distribution of Secondary Growths in Cancer of the Breast," "Lancet," 1889. We must remember that a septic embolus from the lung would pass along a pulmonary vein to the left side of the heart, and thus be able to reach the brain.

removed by operation, show that its presence does not necessarily go against an extensive resection of ribs, if the cavity of the empyema cannot in any other way be closed. We must remember that albuminuria in empyema may have some other source than amyloid disease.

Of the organic diseases that may lead a case of empyema to end in death, the most common are tubercular phthisis, chronic valvular disease of the heart, and chronic nephritis; and it is certain that the results of drink tell very heavily against a case of empyema. The frequency of tubercular phthisis we have already reckoned; but we must in each phthisical patient endeavour to make out whether we are dealing with a tubercular empyema, or with an empyema in a tubercular patient. True primary tubercular disease of the pleura, a diffuse tuberculosis arising on the pleural surface, or in the false membranes of an old pleurisy, may either run its course unheeded as part of a rapidly fatal general tuberculosis, or may be suspected during life, yet hard to diagnose, and still harder to treat with any permanent success. Every case of pleurisy in a patient likely from his history or inheritance to be phthisical must be viewed with anxiety, especially if there be anything unusual in the course or extent of the inflammation, or any relapse; and careful microscopic examinations must be made of the fluid, if there be effusion. In cases where it seems probable that the pleura only is affected, the best hope for the patient may perhaps be a free incision into the pleura, and free drainage; but the chance of recovery, when once the disease is well established, is very small. The hope is slightly better in pleural effusion due to pulmonary phthisis, but still very doubtful. 'I have come to believe,' says Hofmokl (1889) 'that the surgery of the lung and of the pleura in tubercular patients, at all events

PLATE VI.

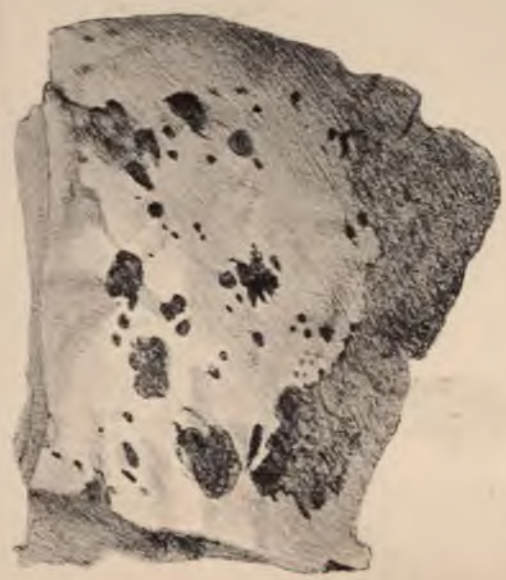


Fig. A.—Ulceration of the Pleura, in a case of Tuberculous Disease of the Lung. [From a specimen in St. Bartholomew's Hospital Museum.]

Fig. B.—Tuberculous Disease of the Pleura in a child; large masses of caseous material beneath the pleura and in the intercostal spaces; a mass in the seventh space is cut across to show how the whole space is infiltrated by it. (From a specimen in St. Bartholomew's Hospital Museum.)

[*Face p. 251.*

as things are at present, does not give us much hope of success.' On the other hand, out of Schede's four cases of empyema in acute phthisis, the empyema was healed by operation in three; the fourth patient died of pulmonary embolism from thrombosis of the femoral vein; in one of my own cases, the empyema, which was already pointing outward, healed quickly. Whether aspiration, or free incision, shall be used for effusions in cases of phthisis must depend to some extent on the character of the fluid and the stage of the disease in the lung. Two things are to be noted in these cases: first, the difficulty of deciding whether the sounds at the apex of the lung are due to phthisis, or simply to pressure of the effusion on the rest of the lung; next, the possibility that sudden withdrawal of a large effusion from a phthisical patient may cause hæmorrhage from a cavity in the lung, as in the following case[1]:—

'I once saw fatal hæmorrhage from the lung, eight hours after aspiration of the chest. The patient was a man 23 years old, in advanced phthisis, with large cavities in the left lung, somewhat extensive caseation of the right lung, and very feeble; then came signs of a left pleural effusion, and a week later there was œdema of the left side, intense pain, temperature 106°. Operation, from the state of his lungs, was deferred for another week; then 2½ pints were withdrawn, to his great relief. Eight hours later, there came a furious hæmorrhage through the mouth, and he died in a few minutes. *Post mortem*, rupture of a small aneurysm in the wall of one of the cavities in the left lung.'

The two drawings (*Plate* VI.) show the hopeless course of most cases of 'tubercular pleurisy.' In one of them the pleura is riddled by the outward spread of infection from the lung; in the other, a true tuberculosis of the pleura, it is invaded over its whole extent by

[1] Fräntzel, "Ziemssen's Handbuch" (1875).

masses of caseous tubercle. With such cases as these, surgery can at most only alleviate suffering, as by the aspiration of an effusion ; but if one had to deal with an early stage of tuberculosis of the pleura, without evident disease of the lung, it is possible that free opening and irrigation of the cavity might do good, just as they sometimes arrest or cure tubercular disease of the peritoneum.

We have now considered some of the dangers after operation for empyema that depend on the general condition of the patient ; next come the troubles to which the wound may give rise.

The Wound after Operation.

Excoriation round the wound is not common, and may be avoided by the use of some simple ointment, which is better than collodion. If anything could be sure to produce it, this would be the lotion of biniodide of mercury, which I have seen in several cases cause sharp inflammation of the skin, nor can I find that it has the slightest advantage over less irritant lotions.

Suppuration in the soft parts round the wound is also very rare ; it comes sometimes of not making a free, clean, well-placed, smooth-edged incision without rough handling of the tissues, or of neglect of antiseptic surgery. If it occurs, it is usually below the wound, and may be accompanied by some slight emphysema. In cases of gangrenous empyema, it is almost sure to occur.

A young married woman, aged 20, came under my care in 1894. Eight weeks before, labour had been induced on account of convulsions ; a fortnight after this, she 'caught cold,' and became feverish, with pain in the left side, and cough. She was admitted to Hospital on the 14th of July, with dulness over the lower half of the left side, and diminished vocal vibration ; but vocal resonance was increased

and breath-sounds and fine crepitations could be heard over the dull area. On the 19th and again on the 24th, a small quantity of blood-stained fluid was withdrawn on aspiration. She now became worse, with profuse sweatings, diarrhœa, sickness; temp. 102-104°, pulse 144; and on the 29th, aspiration followed by incision of the ninth space in the posterior axillary line let out 24 ounces of thin greyish-black purulent fluid, of horribly gangrenous smell. On August 2nd, a swelling below the scapula was incised, but no fluid was found in it. For a few days she improved; then again became worse, with delirium, profuse diarrhœa, and great prostration, and there were also signs of pneumonia at the base of the opposite lung. On August 12th, a large collection of gangrenous pus was opened and drained, near the lower angle of the scapula, and on the 14th another collection, two or three inches below the wound, was treated in the same way. From August 7th to 14th, she was in great danger, but she finally made a complete recovery.

It is in such cases that there is risk of hæmorrhage from ulceration of the intercostal artery from pressure of the tube; and Mr. Godlee advises that the artery should be divided and tied at the operation, if the effusion be found gangrenous.

Caries or necrosis of the ribs, though several causes may possibly produce it, is seldom seen. It may follow infection from an empyema pointing outward, or pressure of the tube, or infection of the cut ends of the rib after resection; but with the use of soft tubes and antiseptic methods it has become rare; and its occurrence after resection may perhaps be due sometimes to an unskilful division of the rib. In 54 *post mortem* examinations at Great Ormond Street Hospital, there was only one instance of necrosis of rib after resection, and three of caries of rib from prolonged pressure of the tube after simple incision without resection; but 20 of the 54 died of tubercular disease, and it is possible that the caries may sometimes be due to tubercular infection.

Exuberant Callus.—We are more likely to get trouble

from a resected rib closing up than from its breaking down, especially if we have been careful to save every shred of periosteum; and I have been compelled on more than one occasion to do resection a second time.

A young man, aged 20, was taken ill about Christmas, 1893, with right pleurisy; two pints of fluid were aspirated, and he was in bed for six or seven weeks. In April, 1894, he came under my care with empyema pointing over the seventh and eighth right spaces in the anterior axillary line, and dulness over the lower half of the chest; no œdema, no bulging of the spaces. The swelling had been diagnosed as a simple abscess. I incised it, but could not find the opening into the pleura, so resected the eighth rib in the line of the scapula, and let out two pints of pus. The pleura was much thickened, the rib very broad and thick, and hard to cut. The abscess in front healed very quickly; behind, a sinus formed, running backward and upward for three and a half or four inches toward the spine. It was kept open with a pewter drain, and became so narrow and rigid that it was difficult at last to pass anything along it. In June, 1894, I laid it freely open, and resected about an inch and a half of the eighth and ninth ribs, and found the eighth rib so restored that there was only a central foramen through a mass of callus; the walls of the sinus were almost as hard as cartilage: I cut away a part of them and dilated the whole track. He now healed quickly.

The Cavity after Operation.

Something has already been said of ill-placed or insufficient drainage: the final failure of a cavity to close, and the treatment of this condition, will be put in the next chapter. For the present, there are four other subjects to be considered: (1) the continuance of profuse or fœtid discharge after operation, (2) the risk of absorption of lotion used for irrigation, (3) the risk of hæmorrhage, (4) the troubles that may come directly from irrigation.

Profuse or Fœtid Discharge continuing after Operation.—The contents of the cavity are seldom fœtid at the time

of operation, unless there be advanced disease of the lung, or the empyema be due to infection from the abdominal cavity: and if fœtor be first observed some days afterward, probably the drainage is at fault, and there has been neglect of a proper method of dressing the wound: and this may lead to retention of large masses of infected fibrin. For example, in 1878, Starcke published the case of a man, aged 23, with empyema of the right side after pneumonia; incision let out more than four pints of greenish sero-purulent fluid.[1] Four days later, he again became feverish, a piece of rib was resected, and two great fœtid masses of fibrin were found and removed.

If we cannot render the discharge inoffensive, by removal of fibrin and by gentle irrigation, or if it remain profuse for some weeks after the operation, we may do well to pack the cavity lightly with a long strip of gauze. Wagner[2] for this purpose uses a single strip, many feet long, of weak iodoform gauze: he advocates it in any case where the cavity is not closed six weeks after the operation, or troubles and failures arise over the drainage, or the discharge remains profuse. The iodoform arrests the suppuration, and the soft gauze, loosely packed, does not hinder the obliteration of the cavity. He makes light of the fear of iodoform-poisoning; but since two of Schede's patients, after very extensive operations, suffered from it, and one died, it would be safer to use some other

[1] In 1878, the use of the spray was so faithfully observed that the patient was *kept sitting up exposed to it for three hours*, till all the fluid was drained out of his chest.

[2] Victor Wagner: "Die Behandlung der Empyeme mittelst Iodoformmull Tamponade." "Wien. Klin. Wchnschr.," 1891, p. 609. Schede has used naphthalin-gauze; or izal-gauze might be tried. Carbolic-gauze would not be free from the risk of poisoning.

kind of gauze. His cases are so valuable that I give an abstract of them.

1. A man shot himself (Jan. 27th, 1880) in the sixth left space in the nipple line; the bullet passed out behind; there was free hæmorrhage; air passed in and out of the wound, and emphysema spread slowly over the whole trunk. He did well for a week, then began to suffer pain, fever, and sloughing of the wound; and when he sat up, thin greenish fœtid fluid poured from it, soaking the dressings and the bedclothes. Feb. 8th, he was very feeble, cyanosed, and breathing with difficulty; a piece of the sixth rib was resected, in the anterior axillary line, and the cavity was irrigated, washed with iodoform emulsion, and drained; but no marked improvement followed. Feb. 19th, several feet of iodoform gauze were loosely packed into the cavity, and renewed at first daily, then every other day. 'The result was extraordinary: the formation of fibrinous clots ceased at once, the discharge became less, and his general condition rapidly improved.' By April, there was only a fistula; by May, he was fully healed.

2. A man, aged 23, had empyema of the right side after pneumonia; a piece of the sixth rib was resected in the anterior axillary line, and 2½ pints of pus were let out. At first, all went well; but, in spite of irrigations and iodoform emulsion, the discharge remained profuse, and *for five months* nothing could check it. After this, a large flap was raised, pieces of the sixth and seventh ribs were resected, thickened pleura was cut away, and the cavity was scraped. Still the profuse discharge went on. A fortnight later, the cavity was packed with iodoform gauze. In a few weeks it was entirely healed.

3. A man, aged 39, had empyema of the right side after pneumonia; incision and resection of sixth rib in the anterior axillary line let out 3½ pints of pus; there remained a fistula, and two and a half months after operation, as it was still open, and necrosed bone could be felt through it, a further resection was made; but the fistula did not appear to be deep, and the wound was therefore closed. A fortnight later (July 15th) he began to be feverish; the ribs were so fallen together that a probe could not be passed between them; his general health was good; he refused further operation. Aug. 16th, during the night, there was a sudden breaking of pus into the lung, causing great prostration. Aug. 21st, resection of pieces of eighth and ninth ribs

let out nearly a pint of pus; the cavity appeared to be bi-locular, one part almost healed, the other opening into the lung. Troubles now arose over the drainage: a soft tube got compressed, a silver one was pushed out, and the use of iodoform emulsion caused cough, pains in the neck, and a persistent taste of iodoform in the mouth. At last, strips of iodoform gauze were used, and under this treatment the fistula was healed.

These excellent cases of Wagner's ought to be studied not only for their own sake, but also because they suggest a way of escape, short of operation, for the patient who is threatened with chronic fistulous empyema.

Risk of Absorption of Lotion.—And as they raise the subject of iodoform poisoning, we may here note the plain duty of the surgeon to avoid the use of poisonous lotions in a large cavity.[1] The lotions that have been from time to time in favour are innumerable—iodine, iodide of potassium, alcohol, chlorinated soda, lime-water, eucalyptus, salicylic acid, zinc, silver nitrate, and, above all, carbolic acid and perchloride of mercury—and many others. Majendie showed long ago that the healthy pleura absorbs poison even more swiftly than the peritoneum; the absorption of serous effusions, and the terrible frequency of acute septicæmia after operation for empyema before Lister's time, show that it does not necessarily lose its power of absorption in disease, though of course a chronic thick-walled cavity is practically non-absorbent. Carbolic acid heads the list, in the records of poisoning after irrigation of the pleura; iodine was often the cause of it, at the time when its use was common; iodoform has several times caused it; and since a collection has lately been made of no less than 35 cases of mercurial poisoning

[1] On the whole of this question, see especially Bouveret, "Traité de l'Empyème."

after abdominal operations, it is evident that the perchloride lotion is unsafe also in empyema. I use either boracic lotion or Condy's fluid; as to iodoform emulsion of glycerine, I admit that it can become well diffused over the whole cavity, for in my own case of fatal gangrenous empyema, the crystals were found *post mortem* scattered even over the very summit of the pleura; but it is an uncertain preparation, and of very doubtful value: 'a lot of it runs out at once, some more is expelled by coughing, and a small portion of it may remain in the chest without doing any harm.' I quote Hofmokl's opinion against the glycerine emulsion of iodoform; but I would rather not follow his astonishing advice, to use a mixture of iodoform in ether, and then plug the wound, being prepared to take out the plug if there should be any fear of the ether expanding!

Hæmorrhage from the Cavity.—Anything more than a very slight transient oozing, from the granulation tissue, or from recent adhesions, is very rare: yet one or two cases have been recorded of serious hæmorrhage; and if the blood does not come from an intercostal vessel, the hope of finding the source of it is small indeed. In one of Schede's cases, very profuse hæmorrhages occurred on the third and fourth days after the operation, and the patient died on the fifth day. The *post mortem* examination showed abscesses in the lung, but the source of the hæmorrhage was not discovered. In four cases, collected by Bouveret, many weeks or months had passed since the operation. I give three of them:—

1. A boy, aged 16, had empyema of the right side, which was followed by a fistula; this was treated (1875) by drainage and counter-opening. About three weeks later, blood began to flow from the fistula, at first in small quantities, then more profusely, so that in a week he was exhausted and

in imminent danger of death. Pieces of two ribs were therefore resected, and the cavity, as no bleeding point could be found, was plugged with no less than eighty pledgets of charpie, arranged kite-tail fashion on a long thread. They were removed on the tenth day. He made a good recovery.

2. A man, aged 29, had a pointing empyema of the right side, which was incised (1875), but a fistula remained. He recovered so far as to get back to work; then, one night, woke with profuse hæmorrhage from the fistula: the blood flowed steadily for half-an-hour, and kept oozing for two days. A day or two later, he was seized with right paraplegia, partial aphasia, and loss of memory, plainly due to cerebral embolism.

3. A young man, after hydro-pneumothorax, probably due to tubercular disease, had empyema, which was treated (1881) by repeated punctures. In Nov. 1881, a piece of rib was resected. During the operation, the intercostal artery was wounded, and was secured. Dec. 1881, it was necessary again to do resection. March 1882, rather severe hæmorrhage occurred, but it was stopped with the use of ergotin and cold irrigations.

This late bleeding from an unhealed empyema is so rare that one need not fear it. Should it be so persistent and profuse as to demand active treatment, the surgeon must bear in mind the possibility that it may come from an intercostal artery, not from the deeper parts of the cavity.

Troubles that may come of Irrigation.—I believe that irrigation of an empyema should be done only if there is some special reason for it, and I have long ago given it up in ordinary cases. A rough irrigation may cause bleeding from the cavity,[1] or may break a recent adhesion.

[1] Bouveret gives the case of a boy, aged 18, with empyema after pleurisy. During irrigation, the fluid became first blood-stained, then almost pure blood. The bleeding stopped with the use of a cold lotion. I know of a similar case, a young man, whose empyema had been washed out daily for a week after operation. One day later, during irrigation, he suddenly had a fit of coughing, a sharp pain in his side, and a foul taste in his mouth; he coughed up a streak of blood, and for some hours felt uneasy and depressed, but no harm came of it.

Again, if there be an opening into the lung, irrigation may cause grave trouble. Again, the careless use of cold lotion for irrigation may be followed by the most disastrous results: I have heard of a case where death followed almost at once.

One great danger of irrigation—that it may suddenly cause syncope, or convulsions, or even death—we must consider at some length, carefully noting the chief features of those cases where it has occurred.

In the first place, we must note that there are other reflex changes, short of syncope or convulsions, that may lead us to a right view of the whole subject. I am not speaking of the wasting of the muscles in the neighbourhood—the pectorales, serratus, and shoulder-muscles, and even those of the arm—which has sometimes been noted in empyema, and is analogous to the wasting of the muscles round an inflamed joint: nor of weakness, or choreic movements in the upper or lower limb, or in both, on the affected side of the body, coming on slowly after the operation, as has been recorded in three cases[1]: but there are slight reflex disturbances directly due to irrigation. Thus, in one case,[2] a youth, aged 19, with empyema of the right side, every irrigation was followed by a rise of temperature to 100°; in another, the temperature rose, after a single irrigation, to 104°, but came back to normal the next day; in several, there have been

[1] Lépine, "Note sur un État Parétique développé dans les membres du coté correspondant à l'empyème." "L'Union Médicale," Feb. 1st, 1876. It is of interest to note that hemiplegia may occur in pneumonia in aged people, as a 'sympathetic phenomenon, without any corresponding cerebral lesion.' See "Charcot's Lectures on Senile Diseases," Syd. Soc. Transl., p. 38.

[2] Baum, "Berl. Klin. Wchnschr.," Nov. 1877; see Bouveret, and Slajner. Also Dr. Sear's paper, Boston Med. Surg. Jour., August 31st, 1893.

curious vaso-motor changes—patches of redness, œdema, or sweating of the neighbouring skin.[1]

These slight and transient disturbances of the temperature, or of the vaso-motor system, seem clearly to show that the occurrence of syncope, convulsions, even death, after irrigation, is also due to reflex action. The other explanations that have been put forward—cerebral embolism, epilepsy, acute poisoning with carbolic acid—are none of them adequate. But, above all, we must note that, in nearly all of these cases, it was especially recorded that an excessive quantity of lotion was used, or the irrigation was given somewhat roughly, or the patient complained of pain.

The first case recorded in England ('Clin. Soc. Trans.,' vol. x., page 16) was Dr. Cayley's, in 1877; Raynaud and Vallin had published three cases two years earlier; Bouveret, in 1888, collected 18; and several have been published since. From this wealth of evidence, I quote the following examples:—

1. A man, aged 36, with circumscribed empyema of the right side, was treated (1877) with repeated punctures, the cavity being each time irrigated through the cannula with a weak iodine solution. *After six weeks of this treatment, a rather larger quantity of the lotion was one day injected to measure the cavity.* He was at once seized with convulsions, his temperature ran up to 107°, and he died in sixteen hours.

2. A man, aged 23, with empyema of the left side, was treated (1875) by incision, followed by irrigation with carbolic lotion. On the fifth day after the operation, irrigation was followed by *pain*, syncope, convulsions, opisthotonos, and death in six hours.

3. A man, aged 27, with left empyema, was treated (1873) by incision followed by irrigation with alcoholized water. On the eleventh day, irrigation, *while he sat up in bed*, was followed by syncope; he revived, and that evening

[1] Goodhart, "Guy's Hosp. Reports," 1877.

he was *again set up, and again irrigated;* syncope, followed by convulsions, trismus, conjugate deviation of eyes to right, sweating, stertorous breathing, and coma; eight hours later, a fresh attack of epileptiform convulsions, and death in three hours.

4. A girl, aged 16, with right empyema, was treated (1875) by puncture, drainage, and irrigation with carbolic lotion. On the thirty-fourth day, irrigation *while she sat up in bed*, was followed by syncope, without convulsions. An hour later it was noted that the right side of the face, and the right arm and hand, were white and swollen, but this soon disappeared. Sweating of the head and neck, slight contraction of the arms, transient paralysis of the right side of the face, were also noted; pupils equal, answering to light, contracted at first, dilated afterward; no strabismus; no convulsions. She never regained consciousness, and died in nine hours.

5. A young married woman, just delivered of a child, had empyema of the right side, treated (1881) by incision and irrigation (carbolic acid, alcoholized water, iodine, at different times). On the thirty-second day, *a rather larger quantity of fluid was injected;* this was followed by headache, dulness, and large roseolar patches over the face and limbs; and these strange results occurred again and again after irrigation for several days; but *they did not appear after special care had been taken to make the irrigation very gently.* On the forty-second day *this precaution was neglected;* again she had headache, and felt confused, and the same rash appeared on her face, chest, and arms; a minute or two later she gave a cry, lost consciousness, and stopped breathing; extreme pallor, dilated pupils, cold sweat, trismus, slight foaming at the mouth, urine passed into the bed. With artificial respiration, she revived in half an hour, and knew nothing of what had happened. The empyema healed in due course.

6. A man, with empyema of the right side, was treated (1867) by puncture and counter-puncture with drainage and irrigation with plain water. On the twenty-fourth day he complained, for the first time, that the irrigation *was painful*, turned pale, and fell back, and for about a minute there was no sign of pulse or respiration; then came convulsive movements of the limbs, foaming at the mouth, trismus, opisthotonos, frightful turgescence of the face, and enormous thrombi formed in both upper eyelids; absolute loss of consciousness, involuntary evacuation; then stertor and coma,

lasting about an hour, followed by loss of power in the right arm, which lasted only a few days.

7. A boy, aged 11, with empyema of the left side, was treated (1871) by incision and irrigation with warm water; *the water was thrown into the chest with an enema-pump.* On the sixth day *some violence was used in irrigation*, and the boy lost consciousness, stopped breathing, and was convulsed; cyanosis, trismus, involuntary evacuation; he remained unconscious, with Cheyne-Stokes respiration, and died that evening, with temp. 104°.

It would be easy to add to these cases, but the picture would be no clearer. We may admit that in this or that case the convulsions after irrigation may have been due to cerebral embolism, or may have occurred in a patient subject to epileptic fits. But there remain many cases where syncope, convulsions, transient paralysis, or some combination of these, is due to irrigation, and to it alone. The patients are not epileptics: if they die, their death is not like epilepsy, and the most careful *post mortem* examination fails to show the slightest sign of cerebral embolism.

The patient may be of either sex and of any age; the empyema may be of either side. Though I have spoken only of irrigation, in two cases syncope followed the probing of a sinus, and the attempt to put back a tube that had been left out. In several instances, where the surgeon repeated the irrigation in spite of the warning, the syncope or convulsions were also repeated. Six or seven deaths have been recorded, and probably a much larger number have been left unpublished. And the two facts to be noted above everything else are that the patient has complained of pain, and that the irrigation has been done roughly. In those cases, therefore, where we must, from the character of the fluid, use irrigation, we must do it very gently, being especially careful not to cause pain or to use even the least force. But in all

ordinary cases of empyema I endeavour to avoid altogether the need of irrigation, by early operation and free drainage.

Troubles arising from the Tube.

Some of these have already been mentioned—caries of the rib, pressure on the diaphragm, retention of masses of fibrin, hæmorrhage from the wound. Even the lung may suffer harm, as in the following case[1]:—

A man, aged 33, was admitted to Hospital with gangrene at the base of the left lung. On May 18th, 1889, a piece of the eighth rib was resected just outside the erector spinæ, the cavity was opened, irrigated, and drained. June 2nd, slight hæmoptysis, and bleeding from the wound, from the touching of a tender spot during introduction of the tube. June 25th, during the night, a severe hæmoptysis, of nearly half a pint; there was also some bleeding from the wound. Next day, the hæmoptysis returned, and was even more severe; and next day it suddenly was so profuse that the patient died. The *post mortem* examination showed that the cavity was nearly healed; a careful search did not reveal the seat of the hæmorrhage. 'It is greatly to be regretted that the drainage-tube was not removed when the irritation began; it seems almost certain that the hæmoptysis was brought about by the tube causing ulceration of a vessel.'

A far more common trouble is the loss of an ill-shaped, badly secured tube within the cavity; in one instance, tube and safety-pin were both lost together.

Those accidents in surgery which are due to the carelessness of the surgeon are seldom recorded; and the loss of a drainage-tube inside the chest is probably no exception to this rule. The following references may therefore be worthy of note,[2] especially as they seem to

---

[1] Reported by Dr. H. Symonds, "St. Bart. Hosp. Reports," 1889, vol. xxv., p. 249.

[2] For further references, see Bouveret, p. 239; and White and Wood, "Treatment of Empyema," Detroit, 1894.

show that there is still some uncertainty as to the right treatment in cases where this dangerous accident has occurred. In two patients under my care in Hospital some years ago, I found and removed the tube in a few seconds with a long slender urethral forceps: no other instrument combines such wide grasp for exploring a cavity with such a slender shaft for passing through a narrow sinus.

M. Duboué[1] has recorded a case where the tube was drawn in during a deep inspiration, and lost in the cavity of a chronic empyema which had been incised six years before, and had never healed. His plan was to fish for it daily with a loop of thin elastic cord; his patience was not rewarded till the fifteenth day, after nearly thirty failures.

Dr. de Havilland Hall[2] refers to a case known to him of a patient 'in whose chest there were about twelve inches of drainage-tubing, owing to the ends having been insecurely fastened together; but no ill-effect had resulted, though the tube had not been recovered.' He quotes two other cases: in one, about six or eight inches of drainage-tube had been lost inside the chest; in the other, part of a gum-elastic catheter. 'In neither case were any signs of the presence of a foreign body in the thorax exhibited.'

Mr. Arthur Durham[3] has recorded the case of a youth, aged 19, suffering from empyema, having a sinus kept open with a plug of lint soaked in carbolised oil. One night the plug was drawn into the pleural cavity during violent inspiration. The patient said that he felt it 'go right flop down on his heart,' and next morning he said that he felt it 'close to his spine.' Mr. Durham explored the cavity with an œsophageal forceps, felt the plug far back in the cavity, and seized and withdrew it without difficulty.

Mr. Brudenell Carter[4] has noted the case of a girl, aged 17, who, after being shot in the chest, had hæmothorax, followed by empyema, which was incised; during delirium, the drainage-tube fell or was drawn into the pleural cavity. This was not removed, but another tube was inserted, and worn

---

[1] "Soc. de Chir.," Paris, 1882, vol. viii., p. 571.
[2] "St. Bart. Hosp. Reports," 1876, vol. xii., p. 63.
[3] "Lancet," 1873, vol. ii., p. 739.
[4] "Lancet," *loc. cit.*

for two years. It was then left out, but the fluid re-collected, and it was necessary again to insert a tube; and this she was still wearing at the time when her case was reported, seven years after the first tube had slipped into the cavity. She was in good health, and hard at work, and had no trouble from the foreign body.

Dr. Symes Thompson[1] has recorded a case in which a piece of gum-elastic catheter, seven inches long, slipped into the cavity of an empyema, and 'remained without exhibiting any signs of its presence till the death of the patient, seven months after, from exhaustion.'

Breschet[2] gives a case where a cannula fell into the chest, and could not be found. A year later, 'the patient did not suffer much from it, but the discharge was more profuse than it had been before the accident.'

Dupuy[3] had a case of empyema of the right side of the chest, where the tube fell into the cavity He dilated the sinus with a tent, and removed the tube, after some trouble, with long curved forceps. Some time afterward the patient came back to the Hospital; the tube had fallen in a second time. Dupuy tried in vain to reach it with a dressing-forceps; he then turned the patient over, so that the sinus was undermost, and at once found and removed the tube.

Hérard[4] refers to two cases. In one, a piece of gum-elastic bougie slipped into the cavity during the night. It was removed through an incision made in the third intercostal space. In the other case, a child, the bougie was removed with a curved laryngeal forceps.

Abbé[5] has published the case of a boy, 5 years old, having an empyema of the left side, which was opened with a free incision. Six weeks after the operation the drainage-tube slipped into the cavity. 'The mother had frequently noticed that on coughing or deep breathing the tube was sucked in or pushed out a couple of inches.' The child now began to have a constant cough. The sinus became narrowed, pus was retained, and hectic fever set in. Ether was given, and, as nothing could be felt with a probe, the sinus was dilated, and different forms of forceps were

---

[1] "Lancet," *loc. cit.*

[2] "Dict. Encyclop.," Art. "Corps Etrangers."

[3] "Des soins à donner aux opérés d'Empyème." Thèse de Paris, 1873.

[4] "Bull. de l'Acad. de Méd.," 1872, p. 479.

[5] "Medical Record," New York, Jan. 1882.

used, but with no result. An inch of the ninth rib was therefore excised close to the sinus, and with the finger the tube was found lying far back in the cavity, parallel to the spine. It was easily removed with a bent probe and forceps, and a quantity of fetid pus and blood clot was let out. The tube was seven inches long. The child made a good recovery.

Toussaint[1] relates a very interesting case of a man, aged 22, with empyema of the left side, whose drainage-tube, the size of a 20 French catheter, fell into the cavity on the 1st of July. It could neither be felt with the finger nor grasped with the forceps. Next day, the wound having been dilated with a sponge tent, the forceps was tried again: the wound was opened up; the patient was turned over; the cavity was washed out; a long curved forceps was used. It was all in vain, and the patient was so weak that nothing more could be done. A few days later he was found to be suffering from empyema of the opposite side of the chest; this was repeatedly punctured, but exhaustion, emaciation, and hectic fever led to his death on the 17th of November, nearly four months after the tube had fallen into the left pleural cavity. At the *post mortem* examination, the tube was found twisted round a thick band of adhesions just below the wound. One end lay parallel to the sixth rib, and was embedded in old adhesions; the other end was lodged in a depression on the surface of the lung.

Tulpius[2] mentions a curious case of a wound of the thorax, which had been kept open with a tent. This slipped into the pleural cavity; six months later it was coughed up into the mouth. The patient recovered.

Lagrange[3] has published a case where a cannula was lost in the pleural cavity. 'A probe passed into the chest gave the sensation of touching a foreign body. As the patient would not allow us to make a free incision, we tried dilating the sinus with a sponge tent. From the time of the accident, his general health became worse.' He died of phthisis; but no mention is made of the cannula in the account of the *post mortem* examination.

---

[1] "Sur les corps étrangers tombés accidentellement dans la cavité pleurale des opérés d'empyème." "Rec. des Mém. de Méd.," vol. iii., pp. 37, 567. Paris, 1881.

[2] Vol. ii., chap. 15.

[3] "Thèse de Paris."

Many of these instances date from a time when the treatment of empyema was very imperfect. A large tube, properly fastened in the wound, or furnished with a broad shield, cannot slip into the pleural cavity so easily as a small cannula or a piece of catheter. But since this disaster does still sometimes happen, it may be worth while to note what is to be learned from this list of cases. They show first that the drainage-tube does not drop into the pleural cavity, but is sucked into it during inspiration; next, that it must on no account be allowed to remain there. The cases published by Abbé, Toussaint, and Lagrange, and others beside these, are clear on this point. There is no evidence that it becomes covered by adhesions; in Toussaint's case, it had been in the cavity for 140 days, and was still loose in it. Next, no time should be lost before attempting its removal; for a fit of coughing may further displace it, and carry it out of reach. Next, if the tube falls into the cavity soon after the operation, before adhesions have formed round the wound, it finds its way downward and backward, and tends to lie up against the spine; but if there are adhesions round the wound, as in Toussaint's case, it may get entangled in these, and lie just below the opening into the cavity.

It is best, therefore, having anæsthetized the patient,[1] and placed him so that the wound is lowermost, first to explore just inside the opening, with an œsophageal or laryngeal forceps. If this fails, the whole cavity should be explored with a urethral or œsophageal forceps, and afterward with the finger; and irrigation may be combined with exploration; indeed, it has been suggested

[1] Or a gentle trial of the forceps may first be made without any anæsthetic

that irrigation alone might succeed in floating the tube into the neighbourhood of the wound; but if this also fails, then a free resection of one or more ribs must be made, and the tube must be sought at the lower and back part of the cavity, in the neighbourhood of the vertebræ.

I have now gone over the chief risks and difficulties that may arise after the operation for empyema, either from the general condition of the patient, or from his wound, or from the cavity itself, or from the drainage-tube. Of my own cases, I have quoted only those few where these risks and difficulties occurred: there is nothing to be gained by printing those that ran a smooth, uneventful course to recovery.

CHAPTER XVIII.

FISTULA. CHRONIC EMPYEMA. ESTLANDER'S AND SCHEDE'S OPERATIONS.

FINALLY, we come to those cases of empyema that remain unhealed after operation: and must first note some practical points as to the manner in which an empyema becomes healed. The average time of healing is put by Runeberg, from a study of 46 cases, at forty-eight days: Bouveret, from 61 cases, puts it at forty-nine days, but 21 of these healed in less than a month: out of Gläser's 20 cases that recovered, 15 healed 'in less than three months': Brünnicke had 3 cases that healed in ten, sixteen, and twenty-two days. But averages are of very little value: those of my cases that ran a smooth course healed in three or four weeks, but one might as well attempt to strike an average in typhoid or rheumatic fever. The important fact is that the period is short or long, according as the operation is, or is not, done early and with strict precautions against infection of the cavity. Bouveret found that the average was 29 days, if the operation was done in the first month of the disease; 54, if done in the second month; and 72, if done in or after the third month. Thus the time, with an ordinary empyema, depends more on the surgeon than on the patient.

As to the method of healing, there are many causes at work together: but for them to combine toward rapid recovery of the patient, the operation must be performed early, and after a right method, and the lung must

still be capable of expansion. Roser's theory, that healing takes place 'from the bottom,' by growth of scar tissue beneath and around the cavity, starting somewhere near the root of the lung, is by itself wholly inadequate. The formation of adhesions, around and inside the cavity, is the chief cause of its obliteration; but for this, the lung must expand, and for the lung to expand, the dressing must be so arranged that air may pass into it from the cavity when the patient coughs, but may not pass through it into the cavity when he draws a deep breath.

'Suppose that for any reason, such as malignant disease of the ribs, one has to resect a large portion of the chest-wall, what happens? The pleura is opened; the air pours into it; the lung collapses in a heap. But is it hopelessly collapsed; is it wholly beyond the help of the movements of respiration? No, with each inspiration it becomes, if possible, more collapsed, because the expansion of the opposite lung draws the last remnants of air out of it: but with each expiration a little air enters by overflow from the opposite lung. Now comes a fit of coughing, and behold the lung that was collapsed now fills the whole pleura, and may even become prolapsed or incarcerated in the wound. You cover the wound with a piece of protective, and apply a deep, elastic, fairly air-tight dressing—and next day, to your surprise, you find the lung safe back in its proper place, moored by adhesions, and following each movement of respiration. All the evils that have been imagined from free admission of air into the pleura—hopeless collapse of the lung, contraction of the chest, distortion of the spine—these things simply do not exist, or, if they do, they may easily be avoided with a proper antiseptic dressing.' (Schede.) Here we have the

whole secret of the healing of empyema: an early operation, a lung still able to expand, and the advantages of coughing, and of a sort of valvular working of the dressings, on the side of expansion.

Hence it is evident that the tube must not be longer than is necessary. It must be frequently cleansed, and, as the days go on, it should be changed for one of smaller calibre. The change of the discharge, from purulent and profuse, to serous and of small quantity; the evidence of physical signs, and of the probe, that the cavity is nearly closed; the pushing out of the tube, not by cough, but by the advance of the granulations—these show that it may safely be left out. But one may leave it out too soon, and be compelled to replace it.[1] In one reported case, the surgeon made three successive attempts, from the twelfth day onward, to do without it, but each time there was a fresh access of fever, and he had to leave it in to the thirtieth day.

The healing of an empyema may be attended by some deformity of the chest, or curvature of the spine. Our surest way to avoid these deformities is to operate early, and to keep the cavity aseptic. Happily, they are not common: there may be a slight circumscribed harmless shrinking of some part only of the chest-wall, giving no trouble and needing no treatment; but a general falling-in of the chest[2] is very rare. I do not remember

[1] In 24 cases (Bouveret) which ran a fairly smooth course to recovery, the tube was left out, on an average, at the end of the fourth week. In nine of these, it was left out before the end of the third week. Of course there is no rule: in one of my cases, a huge empyema, the tube was left out on the third day, and all went well. Cases of empyema from gunshot wound involving the lung, or from perforating disease of the lung, and those that have already broken inward, will need longer drainage, or packing with gauze.

[2] The best account that I know of it is Fräntzel's, in "Ziemssen's Handbuch."

to have seen it in any of my cases. Walshe says it occurs in one out of every twelve or fifteen: but the percentage is probably now much less than that. The progress of this general 'rétrécissement thoracique' is usually very slow, and may go on for two years or more. The final loss of size of the affected side is usually from 1 to 2 inches, but a case has been recorded where 3½ inches were lost. The ribs may almost or quite touch one another, or may overlap like the tiles of a roof: their outer surfaces face somewhat downward, their angle with the spine is narrowed: they move hardly, or not at all, in respiration: the shoulder droops, the scapula is projected outward, the lower border of the chest-wall is brought close to the crest of the ilium. There is no constant relation between falling in of the ribs and curvature of the spine—the former may happen without the latter; if the spine be curved, the convexity of the curve is usually, but not always, toward the sound side; compensatory curves are often absent, and seldom clearly marked. Hofmokl's cases show plainly the rarity of curvature of the spine after empyema. Out of 28 cases, there was marked curvature in 1 only; this was a child six years old, with pointing empyema, treated by incision without resection, and leaving a fistula. In 17, it is expressly noted that there was no curvature; in the remaining 10, there was none, so far as is known.

Such are the chief points in the healing of an empyema after operation, and in the troubles that may attend or follow it. Prevention of these is truly better than cure, and they may most surely be prevented by early, skilful, and strictly antiseptic operation; by good food, wine, fresh air, sunshine, and prolonged rest: and, in some cases, by special treatment to forward

the full expansion of the lung, and to exercise the crippled side of the chest.[1]

We have now to consider what is the treatment of an empyema that does not heal after operation, and will not heal, and continues month after month to bring the patient nearer death from exhaustion or amyloid disease. Cases of non-healing empyema, or rather of pyo-pneumothorax, due to tubercular disease of the lung opening into the pleura, come into the chapter on 'Tubercular Phthisis:' at present, we have to consider chronic fistulous empyema, without phthisis.

The reasons why an empyema may fail to heal are, for the most part, to be found in the presence of conditions exactly the reverse of those which promote rapid healing. They may be illustrated by the following cases[2]:—

1. A farmer, aged 46, was admitted to Hospital in June, 1890. Four years ago he had suffered an illness with acute pain in the left side, palpitation of the heart, and great weakness, and had taken no advice for it. *Two years ago*, a swelling appeared below the left nipple, and this he *poulticed* till at last it broke, and about a quart of matter came away. The discharge continued, in varying quantity, for about a year; then the sinus closed for ten weeks. Then it opened again, and a profuse, thin, sanious discharge went on to the time of the operation.

2. A man, aged 49, was admitted to Hospital in September, 1890. In January, he had suffered 'pleurisy' of the left side, with abiding pain, which was relieved with blisters. In February, a swelling appeared below the left

---

[1] Of these 'breath-gymnastics,' *athmen gymnastik*, the chief are the use of some method of forced expiration, such as blowing water through tubes from one bottle into another—Wolff's bottles—and the sending away of the patient into mountain air, such as that of Davos. It must be remembered that some slight pain is occasionally felt by patients when they first enter these regions of thin air.

[2] Sir William Stokes, on "The Thoracoplastic Operation," Dublin, 1893. Meacham, "A Synopsis of Clinical Surgery," Salt Lake City, Utah, 1893.

nipple, and was *poulticed for six weeks;* and he was at this time coughing up pus through the mouth. About May, the swelling was *punctured*, and 'about five pints' of matter were let out. After this, poultices and irrigations were used up to the time of the operation.

3. A miner, aged 30, had suffered fracture of two right ribs, *nine years ago*, and a few months later had pneumonia of that side, with effusion. Six months later, a quart of pus was removed with the aspirator; and *this method of treatment was used again and again.* Not till *six years* had passed, was a piece of one rib resected. A year later, he was cured by free resection.

One might add a score of cases to show that an unhealed empyema is, as a rule, the direct result of the patient's neglect, or of the surgeon's delay, or of inadequate and useless surgery: but our business now is to enquire how we may most surely and safely cure it. There is, of course, no one kind of chronic empyema: the patient may be young or old, in good health or exhausted, or already affected with amyloid disease. There may be only a short sinus leading to a small cavity, or there may be a huge pneumothorax, a mere remnant of lung, and an enormously thickened pleura of almost cartilaginous hardness. And as there is no clear picture of chronic empyema, so there is no one formal operation for its cure: the treatment ranges from the resection of two small pieces of rib, and the scraping of a sinus, to the most severe form of 'thorax-resection.' With all these operations, two names are chiefly associated—those of Estlander[1] and Schede. The term, 'Estlander's operation,' is very loosely used: nor was he the first to do free resection in these cases. His operation, as Schede says of it, was 'in the air,' and had already been done a few times, at places far apart.

[1] "Revue Mensuelle," 1879. The same operation had been done already by Gayet and Létiévant, in France; and by Küster and Schede, in Germany.

He did not invent a wholly new thing, but his work is hardly less valuable on that account. The method of turning up a single large flap of skin and muscle came later, and Schede's principal contribution to the surgery of the subject is his observation that in certain very bad cases the pleura must be removed to the same extent as the ribs.

Each case must be taken on its own merits: an operation that might be necessary for a man might be wholly unjustifiable on a child. The size and age of the cavity, the health and previous habits of the patient, the exact character of the operation or operations already performed—all these must be taken into account. The size of the cavity may be estimated by the physical signs on auscultation and percussion, the use of the probe, and the amount of the discharge. The smaller the cavity, and the younger the patient, so much more hope is there that a limited resection may suffice; and this may with advantage in some cases be combined with loose packing of the cavity with gauze. But a huge cavity, rigid ribs, a lung past all possibility of expansion, an enormously thickened pleura, all these may combine, in a patient advanced in years, to produce a condition that can only be cured by an operation of very great severity. Nor is there any sure way of knowing the true thickness of the pleura, save by information obtained from some earlier operation which failed just because it left the pleura instead of removing it.

Of all forms of 'Estlander's operation,' it may be said that, as a general rule, the resection of the ribs should be subperiosteal, and that the raising of a single large flap of skin and soft tissues is better than the use of separate incisions, or of a single large incision. In theory, there is, of course, a distinction between Est-

lander's operation, which is a 'plastic' removal of the ribs over the whole length and breadth of the cavity, and any less thorough resection which aims not at obliterating the cavity by atmospheric pressure, but at closing it by freely opening and draining or packing it; but practically this distinction is not strictly observed.

We may do well to consider all sweeping resections of ribs as a last desperate necessity, a confession of failure. There is evidence that a long-collapsed lung may yet expand: its exact power of endurance of collapse is not known: but at an earlier period of surgery, when operation was much delayed for various reasons, it was supposed to be somewhere between two and five months. Ewald had a case, a woman 70 years old, where a lung expanded after six months of compression (even after fifteen and eighteen months, expansion has occurred); and Slajner says he has cured six cases of chronic empyema, with fistula, by Bulau's method. We do not really know when a chronic empyema is quite hopeless, at all events during childhood. The literature of empyema is full of cases which seemed to have drifted past all hope of moderate measures, and yet were cured by resections less severe than a thorough Estlander's operation, and much less severe than Schede's 'thorax-resection.'

But we are none the less bound to admire the accuracy and forethought and splendid results of Schede's operations. At this point, then, let him take up the story. I give an abstract of part of his paper[1] at the Medical Congress at Vienna, in 1890, and of his cases.

'In chronic empyema, when the time has been lost beyond recall, and the lung can no longer expand, the only hope for the patient is that the shrinking of the enormously thickened pleura may at last bring the parts together: for

[1] "Verhandl. d. Congr. f. Inn. Med." ix. Wien., 1890, p. 41.

this to happen, the patient must be young, with his ribs still elastic and freely movable, and the cavity must not involve the whole side of the chest. But with a huge cavity, in an elderly patient, with rigid ribs, and a useless remnant of lung, what good would it be to remove even the whole of every rib, unless the costal cartilages, the soft parts, and the enormously thickened pleura, were all able to fall in? It is only in children that they can thus fall in—they cannot in adults.

For such cases as these, Estlander's operation is wholly inadequate: so long ago as 1877-79, I resected, in more than one case (not children) as many as nine ribs, even going back beneath the scapula; and when this failed, I resected them still further, and once again still further. I also tried simple section in two places, without resection, of a large number of ribs, but it was all in vain; the enormously thickened pleura still refused to fall in. It is, then, the pleura that you must remove: this I thought out for myself in 1878, and I have now (1890) done this operation ten times. One patient, after doing well at first, died of Bright's disease, and one died of iodoform-poisoning; all the others recovered, and were saved from certain death.

My method of thorax-resection is as follows: The incision starts at the outer edge of the pectoral muscle (which may need to be divided a little way), about the level of the fourth rib, and is carried downward in a curve to the lowest point of the pleural cavity, *i.e.*, the tenth rib in the posterior axillary line. It is then curved upward, and carried up along the vertebral border of the scapula, this bone being drawn out of the way by pulling the arm forward across the chest. The incision is everywhere carried down to the ribs, and then the huge flap of skin, with the scapula and the subscapularis muscle, is rapidly cleared and raised. Next comes the sub-periosteal resection of all the ribs over the cavity. If the cavity is nothing less than the whole pleura, it is usually necessary to remove every rib, from the second to the ninth, or even to the tenth, from the junction between bone and cartilage in front, to the tubercle of the rib behind. The resection must be sub-periosteal, to avoid hæmorrhage. The ribs need not be cleared further back than a point a little beyond their angles; then you divide each rib, about the middle, with the bone-forceps, draw the cut ends apart, and break them off; the anterior portion you break off at the junction between bone and costal cartilage, the posterior portion you break off near its vertebral attachment (it breaks, almost always, close to the tubercle). Next, with strong

scissors, you cut away the enormously thickened pleura and the intercostal muscles, etc., over the whole cavity. In almost every case there is a fistulous opening through the pleura. Make this your starting point, and, of course, to avoid cutting the intercostal vessels twice, you must divide the posterior boundary of the pleura first. Each intercostal artery must be compressed, between finger and thumb, by your assistant or by yourself, before you divide it, and ligatured after division.

You now have to cover the great, flat, trough-shaped cavity with your huge flap of skin and muscle. Your chief difficulty here is with the uppermost part of it, which it is, as a rule, impossible to fill up in a satisfactory way: and a tedious fistulous suppuration is likely to go on here, till all the soft parts have finally fallen in; and this is a work of time, for here you have left behind the uppermost zone of the thickened pleura. A space thus left uncovered is very difficult to heal. In one case, I tried refreshing it with a knife, but I cannot recommend this method, as you may get almost uncontrollable oozing from the lung: nor do Thiersch's grafts help you. Some sort of plastic operation is necessary. Schneider resected a part of the clavicle; De Cèrenville resected a small part of the first rib.

The whole procedure takes a year, or longer. And this is the strange part of it, that so soon as the scarring is complete, and the patient begins to use his arm again, the lung begins again to expand and to act; the mangled look of the chest begins to amend, the side regains its shape, the lateral curvature, so frightful at first, disappears; and at last, when the patient has his clothes on, there is no very marked deformity after all.'

I have been careful to transcribe accurately Schede's account of his method. It is certainly not an operation that most surgeons would welcome if they could honestly avoid it, nor would the results of it, if it were generally practised, be such as Schede himself has obtained. Still, the danger of it is less than it appears at first sight: the desperate state of the parts is itself an advantage; the lung is past considering, the whole cavity is already opened to the air: one is not really operating on an empyema, but removing a great cage or frame of ribs

and thickened pleura, beneath which there are no structures that one need either respect or fear.[1]

Finally, one must study his cases very carefully. The first five are cases of very extensive resection, but without removal of the thickened pleura; the last seven are true 'thorax-resections.' *Plate* VII, copied from his work, shows the condition for which he advocates this 'thorax-resection.'[2]

Five Cases of Extensive Resection of Ribs for Persistent Empyema.

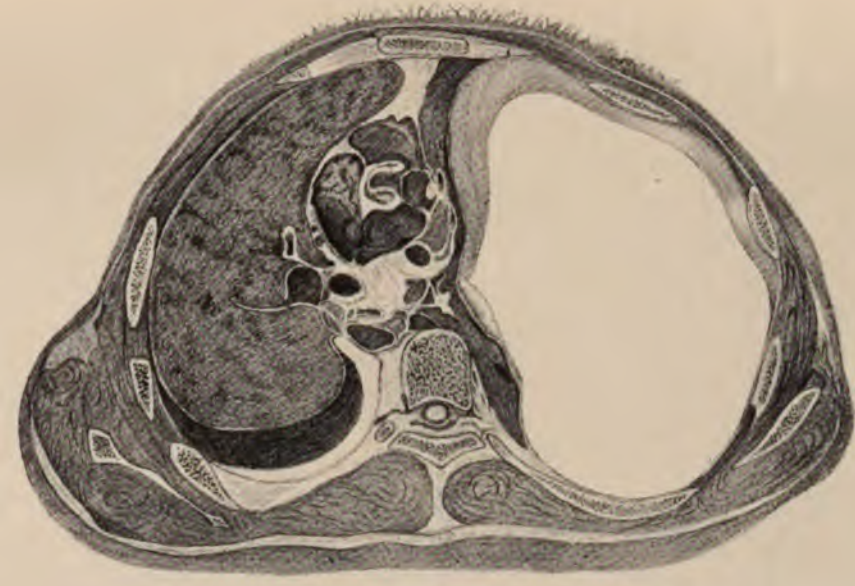
1. Male, aged 22. Duration of disease not known. Old circumscribed fistulous empyema, occupying lower part of left side of chest, at the side and behind. The first operation was only resection of a small piece of the seventh rib, followed by drainage. Business affairs obliged him to leave the Hospital. A fortnight later, no definite shrinking of cavity. Resection of sixth to tenth ribs, 6 to 10 cm. of each,

[1] In 1892, at the meeting of the British Medical Association at Nottingham, Mr. Croft proposed that in some cases of this kind one might even remove the remnant of the lung. 'When an enormous pleural cavity is bounded on one side by a collapsed moveable swinging dangling lung, and on the other side by rigid bony wall, would the removal of the useless swinging lung, at or near its root, be a safe and useful measure? I am disposed to think that its presence is an obstacle to the cessation of discharge from the pleura, and that its removal would be a step half-way to cure. I am supposing that the lung is useless as a respiratory organ, and that adequate measures for its fixation have failed of their purpose. The loss of such a spoiled organ should prove to be a gain.'—"Brit. Med. Jour." 1892, ii, 245.

But apart from the difficulty of knowing whether the lung has or has not gone past hope of expansion, there is this further objection to Mr. Croft's plan, that the remnant of lung may not be moveable, swinging, and dangling, but as in *Plate* VII, fixed, flattened and obliterated.

[2] But we cannot without reserve accept his assurance that after operation the outline of the chest becomes in time greatly improved: his own cases, and those published by Mr. Pearce Gould and Dr. Meacham, show that we can save the patient's life, but only at the risk of great permanent deformity. An interesting case of the operation was published by Mr. W. G. Spencer in the Transactions of the Clinical Society for 1894.

PLATE VII.



Transverse section of the chest from a fatal case of large Chronic Empyema of the right side: showing huge cavity, thickened pleura, obliteration of lung. Given by Schede to illustrate the need of "Thorax-resection" in such cases.

[Face p. 280.

and free incision of the pleura over the whole extent of the cavity. Drainage. Discharged cured in six weeks.

2. Female, aged 37. Large chronic fistulous right empyema. Nearly a year ago, it had been incised in the sixth space, posterior axillary line, and the incision had never healed. Profuse discharge from fistula; marked falling-in of chest, definite lateral curvature of spine; an immense cavity. Resection of fifth to eighth ribs, from juncture with their cartilages back to their tubercles; they were welded together with bridges of bone, and lay so close that their intercostal spaces were quite obliterated. The pleura had become a tough layer of tissue, 2 cm. thick. Incision through the pleura showed that the lung was not wholly collapsed; its surface was distant 3 cm. from the chest-wall. Drainage; irrigation. Healed in seven months.

3. Male, aged 18. Relapse after typhoid, followed by pleurisy and empyema. After repeated simple punctures of the serous effusion, Bulau's drainage was begun in April, and later the cavity was repeatedly irrigated. June 15th, Bulau's method left off; July 8th, fistula closed. Then the patient became feverish, and on August 1st the fistula re-opened, and discharged a quantity of pus: further drainage had no result. Nov. 11th, fistula in sixth left space, anterior axillary line, leading into a cavity 3 to 5 inches in diameter. Curved incision, convex downward, from edge of sternum to posterior axillary line, reaching as low as eighth rib. Resection, about 9 cm. each, of sixth, seventh, and eighth ribs: they overlapped like the tiles on a roof. Incision of the pleura, evacuation of the cavity: a second enormous flattened cavity was now found, extending over nearly the whole posterior aspect of the chest-wall. It was necessary again to resect sixth and seventh ribs right back to their tubercles, also 8 cm. each of the fourth and fifth ribs: altogether about 80 cm. of ribs were removed. Pleura laid open freely, huge cavity scraped, whole space loosely packed with iodoform gauze. Later, irrigation with astringent solutions. Discharged, completely cured, April 17th. Naphthalin gauze was also used.

4. Little girl, aged 7. Large chronic left empyema, with fistula in seventh space just outside nipple line: dulness over whole side, except just round fistula: profuse discharge, slight retraction of chest-wall. May 2nd, the ribs so overlapped that resection of eighth and ninth ribs only had no effect. It was necessary to resect all ribs from second to tenth (about 80 cm. in all); the walls of the huge cavity then fell together. It was packed with iodoform gauze: some

collapse after operation: on tenth day, slight iodoform poisoning. The cavity quickly closed, the lung expanded completely, the deformity disappeared, the ribs were regenerated. Discharged, 7 lbs. heavier, December 15th.

5. Male, aged 32. After pneumonia, right empyema (? tuberculous origin), which was treated from April to August by aspiration drainage without success. In August, resection of eighth and ninth ribs; in October, fistula, flattened cavity, and long sinus running up to level of middle of scapula. November 2nd, resection of seventh and eighth ribs (20 cm. each) and ninth rib (16 cm.), free incision of pleura, scraping of contents, mixed with flakes of pus and fibrinous deposit, packing with iodoform gauze. Long sinus scraped, irrigated, and drained. By January (in spite of intercurrent peri-typhlitis) cavity healed, small external fistula healing. Later, acute phthisis.

Seven Cases of 'Thorax-Resection.'

1. Boy, aged 9. Three years ago, pleuropneumonia, followed by right empyema, which broke outward, and has discharged ever since. Very large empyema; fistula in sixth space, just outside nipple line; general condition very bad; advanced amyloid disease. April: Resection of sixth rib, counter opening by resection of tenth rib; evacuation of large quantity of fœtid pus, irrigation, thorough drainage. Marked improvement in general health. But the pleura was 3 cm. thick, and of almost cartilaginous hardness. The size of the cavity was not reduced; the ribs had fallen in a little, but it was impossible they should fall in enough, or that the lung should expand enough—so it was decided to do thorax resection, *by repeated operations.* May 20th: Long curved incision, rising upward toward vertebral border of scapula. Ribs so approximated that they were in contact. Resection of sixth to eleventh ribs, about 12 cm. of each. Then the rigid cicatricial pleura was removed over the whole extent of the opening. Intercostal arteries compressed before division; bleeding not severe. Cavity packed with gauze. Complete recovery without fever. June 12th: Soft parts raised by an incision carried backward and upward to spine of scapula: scapula and subscapularis thoroughly freed to an equal extent, arm drawn well forward, second to fifth ribs resected. Removal of thickened tissues as at previous operations: skin-flap applied to fill gap thus left. A month later, a plastic operation was needed, and for some months

there remained a fistula. By May of next year, all was healed: two years later, there was marked falling-in of chest-wall: later still, there was lateral curvature, but not excessive: considerable recovery of lung; signs of amyloid disease vanished; general condition very good; movements of arm wholly unhindered.

2. Male, aged 29. Three years ago, right empyema: after long delay, incised: later, resection first of sixth, then of seventh rib. Now, general condition good: very marked falling-in of chest-wall: empyema cavity of considerable extent, holding 50 cub. cm. In the hope that a complete 'thorax resection' was unnecessary, resection of fifth to eighth ribs only (5 or 6 cm. each), and free opening into the cavity, followed by packing, astringents, etc., and compression of chest-wall with strapping. Only slight improvement; cavity still 30 cub. cm. March 31st, 1886: Resection of second, third, fourth, and ninth ribs (6 to 10 cm. each), nearly up to the spine; very troublesome hæmorrhage from latissimus and other muscles; ribs much thickened by osteophytes. Total ablation of soft parts; scraping and packing. No reactionary fever, still cavity did not close. May 24th, Resection of seventh rib (10 cm. anterior end), and of remnants of vertebral ends of eighth to tenth ribs. Cavity covered by flaps taken from scapular and abdominal regions. June 26th: went home with a fistula. By next spring, completely healed.

3. Female, aged 17; general condition very grave, and so feeble that she turns faint on sitting up in bed. Three years ago, after severe pleurisy, empyema, neglected for four months, then only punctured. Then continuous syphon-drainage, no result. Then resection, freely, of several ribs; but no marked diminution of cavity. Present general condition as above; fistula about tenth space, far back. Great falling-in of chest-wall, all the ribs touch; enormous cavity; absolute collapse of lung. May 24th: Huge flap turned up, including scapula; subperiosteal resection of second to tenth ribs in their whole extent (160 cm. in all), then removal of soft parts with the huge cicatricial pleura, at least 2 cm. thick: loose packing. Sent home in five weeks; complete healing (retarded by a fistula) by February. 'Very striking in this case was the gradual disappearance, after complete healing of the wound, of the curvature, which was at first very marked; and at the same time the gradual resumption of a part of its function by the collapsed lung.' The movement of the arm was in no way hindered.

4. Male. Seven years' suffering from enormous empyema of whole left side of chest. Punctured in third week; later, on two occasions, extensive resection, but without any success. Present condition: tall, pale, wasted, wretched. Enormous cavity (second to ninth ribs), daily discharge profuse. July 7th: Resection of second to ninth ribs in almost their whole extent (150 cm.); removal of soft parts; loose packing with iodoform gauze. Hæmorrhage not severe; no fever. On July 10th, signs of iodoform poisoning, and death one week after operation.

5. Male, aged 28. Two and a half years ago, left pleurisy, followed by empyema; two years ago, continuous syphon-drainage. He was kept in bed for six months, and then got about with a bottle; discharge always very profuse. Present condition: pale, wasted; drainage track in fifth space, between nipple and axillary lines. August 29th: Large flap; exposed ribs not only touching, but so twisted that their anterior surfaces looked upward. Resection of fifth, sixth, and seventh ribs (12 cm. each); removal of soft parts including pleura, which was as thick as one's finger, and of extreme hardness. Loose packing with iodoform gauze. He did well for four months, then signs of chronic nephritis set in; he lost ground, and the discharge again became profuse. Discharged at own request June 23rd.

6. Male, aged 24. Three and a half years ago, Nov., 1884, empyema, which burst of itself. A month later, it was incised and drained; drain fell into cavity, and could not be found till nine months later. Nov., 1886: Resection of two ribs, followed by irrigation; no effect. April, 1887: Resection of several upper ribs, in front of chest; no marked effect. April, 1888: General condition good; great falling-in of chest-wall, fistula fourth left space, anterior axillary line, also two fistulæ in front. Very large cavity; almost entire collapse of lung (but small areas in front and behind where breath-sounds were heard). May 2nd: Incision from spine of scapula, down alongside its vertebral border, and curved forward to eighth costal cartilage; all soft parts cut through down to the ribs, and the huge flap, including the scapula and the subscapularis muscle, raised and drawn upward as high as possible. Then subperiosteal resection of second to eighth ribs, from cartilages to tubercles. Next, with scissors, the whole outer wall of the cavity—intercostal muscles, periosteum of ribs, and enormously thickened (2 cm.) rigid pleura—was cut away. Bleeding easily controlled, intercostal arteries compressed between finger and thumb, before

division, and caught with forceps. Iodoform gauze, in layers, laid over thickened pulmonary pleura; huge flap laid down and drained; uncovered area (hand's-breadth) left at lower circumference of wound. Long delay in healing, 'because in this case, as in others, the pulmonary pleura showed itself very incapable of producing healthy granulations'; all sorts of applications used in vain. August 20th: Discharged; large, granulating surface in axilla, which had frequently given rise to slight bleeding. Thiersch's grafts had failed. Finally, a year after operation, a plastic operation was done while he was in Hospital again for removal of a tuberculous kidney. General health very good: marked curvature of whole dorsal spine, convex to left; lung acts now more or less over its whole extent. He still can hardly raise the arm at all.

7. Male, aged 20. Three years ago, right empyema, which burst of itself. Six months later, resection of several ribs. Great falling-in of chest-wall: three fistulæ toward front of chest, leading into an enormous cavity. July 24th, 1888: Thorax resection as in previous cases. Subperiosteal resection of fourth to tenth ribs, in whole length from cartilage to tubercle: they were found overlapping, and here and there welded together by bridges of bone. Removal of soft parts and of greatly thickened pleura; pulmonary pleura scraped, covered with gauze, flap replaced. Bore operation well; all healed but the fistulæ, then things came to a standstill, and so remained for months. June 3rd, 1889: Upper part of scar was opened up, and cavity behind upper ribs exposed. Dec. 11th: Resection of second rib (4 cm.), and third rib (6 cm.) in front, cavity here freely exposed, scraped, drained with counter-opening, and packed with gauze. Complete recovery, with no marked lateral curvature, and good action of lung.

It is evident that operations so severe as these are justified only as a last resource, in cases that have been long neglected, or subjected to treatment so inadequate as to be useless. They may be compared to amputation at the hip in the last desperate stage of hip-disease—the last act of a tragedy that might perhaps have ended differently if the disease had been better treated in its earlier stages.

CHAPTER XIX.

ABSCESS OF THE LUNG. BRONCHIECTASIS.

WE have now come at last to those diseases of the lung itself that may admit of treatment by operation; and, if we look back over the ground already covered, it is evident that this new field of work has been reached by the advance, all along the line, of the whole aim and method of the surgery of the chest.

HISTORY.

Thirty years ago, the pleura stood between the surgeon and the lung, just as the peritoneum blocked the way of abdominal surgery; and so long as the operations on the pleura were irresolute and inadequate, there could be no advancement of operative treatment of the lung. Yet from time to time there were men ahead of their age. Such were Baglivus (1710), who treated a wound of the lung by free incision of the pleura, and recommended the same treatment for 'phthisis ab ulcere pulmonum,' and De Bligny (1720) Barry, and Boerhaave, who, a few years later, advised free incision of lung cavi ties. About 1780, David recommended incision in cases of simple abscess, provided the pleura was adherent; in 1783, Pouteau published a case cured by this treatment; and in 1812, Richerand spoke of incision of the lung as if it were now established beyond the reach of criticism, and suggested the use of exploratory punctures in doubtful cases of abscess. In 1818, Zang reported fifteen instances of incision of the chest-wall, seven for

empyema, eight for abscess; in 1830, Krimer made careful study of the relation of pleural adhesions to operations on the lung; and in 1844, occurred the celebrated case of Hastings and Storks,[1] which aroused great interest in England, and a storm of criticism.

But in 1850, Graux, of Brussels, published thirteen cases of incision of pulmonary cavities, without a single success; and for the next twenty years the treatment of empyema was so bad that there was not likely to be any advance in the surgical treatment of the lung itself. A further check was given to it by the tragic death of a surgeon, who had operated on both lungs of a patient with tubercular phthisis; the patient died almost immediately, and the surgeon, being threatened with a judicial enquiry, put an end to his own life. About 1870, with Lister, the old order changed, giving place to new; in 1873, Mosler, W. Koch, and Bull of Copenhagen, were among those who revived the surgery of the lung; and then come many other names, both abroad and in England, which, happily for us, do not yet belong to history. A great quantity of experimental work was now being done on the lung and its surgical treatment; perhaps the most important observations are those of Gluck in 1881, Block in 1882, and Schmidt and Biondi in 1884. A short account of these and other experiments is given in the chapters after this one.

For this history of the subject, and for a most admirable review of the whole field of these operations, we have Truc's important monograph,[2] and the excellent

---

[1] "Med. Times and Gaz.," Dec. 1844. See chapter on "Tubercular Phthisis."

[2] "Essai sur la Chirurgie du Poumon," Paris, 1885. See also the valuable paper by Dr. Douglas Powell and Mr. Lyell, "Med. Chir. Soc. Trans.," 1880, p. 333.

address delivered last year by Reclus, before the French Surgical Congress. This address, and the long discussion that followed it, are of the very highest value. I have, therefore, put a full translation of it as an Appendix to this book: it appears to me perfect alike in its tone and in its arrangement of the whole subject. Truc's essay is, I think, equally valuable; and if we compare the two writings, 1885 and 1895, we may see reason to believe that the surgery of the chest is now near its greatest height, and that its further upward course is checked by no fault of its own, but by restrictions imposed on it by the natural limitations that are set to all surgery, as things are at present.

Diagnosis.

Probably, as with the abdomen, so with the chest, surgery is just now stronger in method than in diagnosis[1]; and there are plenty of recorded operations on the lung which were begun in the belief that the disease lay outside and not inside it. Some examples of this have been already given; and Fräntzel records two cases where he thought he had to deal only with an empyema, and found instead a tubercular cavity in the lung. The surgeon, who has assured himself of the presence of pus within the chest, may yet be wholly unable to make sure

[1] 'The field of lung-surgery is still within narrow limits, if we count only those indications for operation which seem to promise complete success. It is true that large portions of the chest-wall, and of lung adherent to it, have been removed, and that cases of gangrene, abscess, hydatid disease, and bronchiectasis, have been operated upon successfully; but so many failures have been recorded in cases of this kind, that we must learn to select our cases better, if we are to improve our results and our method of operation. Most of those, therefore, who are now working at the surgery of the lung, lay special emphasis on the necessity for defining the exact indications for operation.'—Kochler, "Deut. Med. Wchnschr.," 1895.

before operation whether it is in the pleura or in the lung; and the following cases, quoted by Truc, illustrate this sort of unpremeditated surgery.

1. A man, aged 44, was admitted to Hospital suffering intense dyspnœa, with two large abscesses in the neighbourhood of the right breast, communicating with each other. Pressure over them gave rise to cough and abundant purulent expectoration; the diagnosis was therefore made of empyema, pointing under the skin, and communicating with the lung. Incision, near the breast, let out a large quantity of pus, and gave him great relief; but he died a day or two later of sudden acute pleurisy of the opposite side. The *post mortem* examination showed no empyema, but a very large abscess of the upper lobe of the lung.

2. A boy, aged 6, was admitted to Hospital with cough, dyspnœa, prostration, and signs of left pleural effusion; after exploratory puncture, the chest was incised, and twelve ounces of pus were let out. The wound was allowed to close, but had to be re-opened and packed. Irrigation caused cough and pain in the chest, and, if pushed too hard, some of the lotion came through the mouth. Next day, the child coughed up a clot of blood, and similar clots were found in the wound. About a week later, during irrigation, the child suddenly felt suffocated, fainted, and only revived after artificial respiration. A week later, his general condition was very bad; prostration, delirium, and other signs of acute septicæmia. It was now possible to make out two communicating cavities, one in the pleura, containing clear fluid, the other, more purulent, in the lung. A better method of drainage was now employed, and finally he made a complete recovery.

In some cases, it is impossible in making the diagnosis of empyema to exclude the possibility of abscess of the lung: in others, an abscess may be present, but the diagnosis of it may be impossible. It has even been proposed to divide these cases, from a clinical point of view, into latent, doubtful, and certain; the first only discovered *post mortem*, the second only suspected, but not giving any clear sign of their presence, the third diagnosed during life from their symptoms and physical signs. Or the surgeon may be able to diagnose and

localize suppuration in the lung, and yet may not know whether he has to deal with a simple abscess, gangrene, bronchiectasis, or a tubercular cavity. Or he may exactly diagnose and treat an abscess, and yet fail to cure his patient because there are other cavities, elsewhere in the lung, that he has left unopened or undrained.

Again, to increase the difficulty of diagnosis, there may be no profuse purulent expectoration, no loss of vocal vibration over the cavity.[1] But in most cases, the history of a previous acute inflammation, or of some condition likely to cause septic embolism, and the physical signs of localized dulness and loss of breath-sounds, pain, fever, and embarrassed breathing, a localized tenderness on pressure, the appearance of pus in the sputa, and perhaps, under the microscope, the admixture of elastic fibres or of blood pigment—this state of things, together with the absence of any clear evidence of tubercular phthisis or of pulmonary gangrene, may lead the surgeon at least to suspect an abscess of the lung, and to act on his suspicions.

Cases illustrating Abscess of Lung.

The following cases[2] will illustrate some of these many difficulties of diagnosis, and raise questions of treatment which we must carefully attempt to estimate. The first is of interest for its age, as well as for its own sake.

1. In 1753, a man, aged 30, was admitted to Hospital nine days after the onset of acute inflammation, with severe pain in the right side of the chest, worse on pressure over the seat

[1] See Dr. Porter's essay on Abscess of the Lung, "Journ. Amer. Med. Ass.," March 7, 1891.

[2] For references, in addition to those already given, see Hofmokl, 'Beiträge zur Lungen-Chirurgie,' "Wien. Med. Presse," 1892; Fairchild, "Wien. Med. Wchnschr.," 1893, p. 833; Teale, "Lancet," June 5th, 1884.

of pain. The day after admission, there was profuse purulent expectoration, which became persistent; the pain remained unmoved without the least variation, always at the same place, and it was noted that the soft parts here were swollen. The patient refused operation for no less than three months, and steadily lost ground; at the end of this period, an incision was made through the swelling, and air escaped with such force as to blow out a candle; no pus came with it, but an hour later there was a profuse discharge. For some days the patient continued to become more and more enfeebled by the profuse suppuration, but he finally made a complete recovery.

2. A man, aged 44, was taken ill in December, 1880, with shiverings, vomiting, pain about the region of the liver, and loss of flesh; no cough, no signs of disease of the lung. On March 1st, 1881, he had signs of right pleural effusion; aspiration over the base of the lung gave only a few drops of yellowish purulent fluid, but somewhat higher up it drew off a whole pint of greyish pus; there was, therefore, a double cavity, or two cavities. On March 16th, his general condition was worse, and he had fœtid expectoration; there were signs that the cavity contained air as well as fluid; puncture above and a little in front of the angle of the scapula showed the pus was fœtid, and an incision (without anæsthetic) was made into the pleura. Only a small quantity of serum flowed out; the surface of the lung was uneven, and slightly adherent here and there; the lung itself felt hard, doughy, inelastic, and non-crepitant. An opening was made into it with the trochar and the finger, and two pints of extremely fœtid fluid were let out. For a very long time—several months—he was dangerously ill with all the signs of chronic septicæmia; finally, after a profuse diarrhœa, he began to improve, and made a complete recovery. The drain was not left out till nearly the end of August.

3. A woman, aged 24, was admitted to Hospital on July 13th, 1882, desperately ill, with the signs of a large collection of air and fluid in the right side of the chest. In childhood, she had frequently had pneumonia, and at 15, 'typhus'; four years ago, she had suffered an attack of nephritis, with jaundice, and profuse fœtid expectoration. On admission, she was emaciated, exhausted; feeble pulse, dyspnœa, intense jaundice, profuse fœtid expectoration, about a pint and a half daily. A piece of rib was resected, Paquelin's cautery was passed into the lung in the axillary line, and a cavity was found in it the size of the fist, extending downward to

the diaphragm, traversed by bridles of fibrous tissue. These having been destroyed with the cautery, aspirating needles were pushed through the wall of the cavity, and found fœtid pus; and the cautery, passed along the track of the needles, opened a huge cavity the size of a child's head, full of fœtid pus and débris of lung tissue. It was drained and irrigated; the dyspnœa ceased, but the patient was too far gone to recover, and died a week after the operation.

4. A man, aged 37, was admitted to Hospital on March 6th, 1883; he had been subject to cough for a year and a half, but never laid up with it; on admission, he had shiverings, pain in the side, loss of appetite, slight fever; there were physical signs of one or more cavities at the apex of the right lung; he was somewhat cyanosed, his breath was fœtid, and his daily expectoration amounted to half a pint, and contained pus, epithelial cells, and elastic fibres, but no tubercle bacilli. The first exploratory puncture, in the second space, failed; the next, in the same space, let out a little fluid containing pus cells and altered pulmonary epithelial cells. A piece of the second rib was resected, and a trochar and cannula were pushed into the lung; the track was dilated, and a thick-walled cavity, traversed by a tough bridle of fibrous tissue, was found. There had been no oscillation of the exploring needle, and the operation was not followed by pneumothorax. The cavity was drained and irrigated, and he healed well, though he was feverish for a fortnight after the operation, and also had slight poisoning from carbolic acid. In October the scar gave way, and a large quantity of pus escaped; then all healed, and he remained well.

5. A man, aged 55, convalescent after pneumonia, was again taken ill, with a rigor, cough, and purulent expectoration, and in spite of careful nursing got steadily worse. The breath-sounds were weak in front, and wholly lost over part of the lung behind, where there was also dulness on percussion. Several attempts to find pus with the aspirating needle were unsuccessful; at last it was found on puncturing the fifth space just in front of the angles of the ribs. The needle was left in as a guide, and a piece of the fifth rib was resected; a large cavity in the lung was found shut off from the pleura by adhesions, and eleven ounces of pus let out; free drainage and irrigation were used, and he slowly made a good recovery.

6. A man, aged 32, suffered pneumonia of the right side at the age of 25, and had been subject to cough from that

time onward. A fortnight before admission to Hospital, after exposure to cold, he had rigors, fever, and severe fits of coughing, with profuse fœtid expectoration ; and he now presented physical signs of a cavity in the lower part of the right lung, and of recent pleurisy on the left side. A piece of the seventh right rib was resected, below the angle of the scapula. There were pleural adhesions, the pleura itself had a greyish tint, and the lung beneath it felt unduly hard. The point of a Paquelin cautery was sunk into the lung in different directions to a depth of 1 to 2 inches ; and at the fourth puncture ($2\frac{1}{8}$ inches deep, passing backward and inward) some air and a little purulent mucus escaped. The wound was left open, and packed with gauze. He immediately began to improve, and rapidly recovered.

7. A woman, aged 25, having signs of an abscess within the chest, communicating with the air-passages, gave the following history. When she was only 12 years old, she had suddenly, after a cold, showed signs of a cavity in or opening into the lung, and for fourteen years had never for a day been free from more or less profuse purulent expectoration ; but her general health had been fairly good, except that at times she was thin and weak, and the sputa were then especially offensive. In 1892, after an attack of influenza, she had purulent pleurisy of the left side, which was treated with incision of the fifth space in the anterior axillary line, and drainage for a fortnight. Her general condition was now very grave ; she was weak, pale, emaciated, and unable, for shortness of breath, to walk or make the least effort. The physical signs (amphoric breathing, occasional gurgling sounds, and, at a point between the angle of the scapula and the spine, well-marked sounds of air bubbling through fluid) led, after repeated examinations by many physicians, to the following diagnosis : Chronic bronchitis, with general dilatation of bronchi over the whole of the left lung ; circumscribed empyema of the lower part of the left pleura, probably secondary to gangrene of the lung ; and a fistulous opening between the pleura and the lung. The expectoration was profuse, purulent, and horribly fœtid ; it came in a rush two or three times a day, after a paroxysm of coughing and choking, and not continuously ; repeated examinations of it failed to find the tubercle bacillus.

Operation, May 9th, 1894. Resection of seventh and eighth ribs near the spine ; the pleura was thick, tough, and firmly adherent ; the lung was absolutely hard, and scarcely bled on incision ; a huge cavity of the whole of the lower

lobe was laid open. Its front wall, of a very thin layer of condensed lung-tissue, covered the pericardium, and the movements of the heart were plainly visible; its walls were smooth, even, of a greyish tint, covered here and there with bronchial mucus; it was ten inches in vertical measurement, running upward as high as the fifth space, in the shape of a narrow sac constricted here and there. The eighth and ninth ribs were now very freely resected, and a large opening was made into the huge cavity, and it was packed with sponges and sterilized gauze. The patient at once began to amend; and after some subsequent operation in July for the cure of a fistulous track that remained after the operation, she made a complete recovery.

Careful study of these cases will put us in possession of the chief facts of the nature, course, and treatment of abscess of the lung. It is evident that a right diagnosis may be hindered by difficulties that are almost insuperable, and that the disease ranges from a single huge excavation of the lung to a condition practically the same as bronchiectasis. Again, it may closely imitate tubercular phthisis, acute gangrene of the lung, or empyema communicating with the air passages; and from the wide range of the disease, and its resemblance to other morbid conditions, it must often be doubtful whether an operation is likely to be successful, or is even advisable.

Cases illustrating Bronchiectasis.

I give next some cases[1] of operation for bronchiectasis: it will be noted that this condition is, on the whole, unhopeful. The surgeon may give relief, but can hardly hope to effect the permanent cure of his patient; his chance of success is in inverse proportion to the number of small separate cavities in the lung; and the specimen (*Plate* VIII) shows clearly how this disease tends to pass

[1] See Truc, p. 59; Biss, "Med. Chir. Soc. Trans.," 1884, p. 217; Hofmokl, "Wien. Med. Presse," 1892, p. 1904.

PLATE VIII.

Advanced Bronchiectasis of the Lower Part of one Lung: showing multiple small cavities, illustrating cause of failure in operation for this disease. (From a specimen in the Royal College of Surgeons' Museum.)

beyond the help of surgery. I believe that the opinion of M. Reclus (see Appendix) represents fairly the general estimate that surgeons have formed of operation for this condition.

1. A man, aged 25, who had for seven years suffered from cough and weak chest, was admitted to Hospital on Nov. 22nd, 1882. Nearly two years ago, he had been attacked by pleurisy of the right side—no effusion. For the last nine months his cough had been severe, with profuse expectoration. The right side of the chest was sunken, and the lower part of it did not move in respiration; general bronchitis, friction-sounds over the base of the left lung; over the right lung behind, below the angle of the scapula, dulness, loss of breath-sounds and of vocal vibration; slight fever, albuminuria; profuse fœtid expectoration. Aspiration of the dull area drew off some sero-purulent fluid; and, two days later, percussion here gave a tympanitic note,[1] and there was cavernous breathing, with coarse râles. *Diagnosis*, general bronchiectasis, with a large cavity, thickened lung, adhesions at the right base. *Operation*, Nov. 25th: incision of ninth space, outside the scapular line; a deep track was made into the lung, with the Paquelin's cautery and the finger, but no cavity of any considerable size was found. Fœtid gas came from the wound in the lung; it was plugged for a few hours, and then drained. No improvement followed the operation; subsequent exploratory punctures gave no result: the patient died a month after the operation. *Post mortem*, the opening in the lung led through a narrow sinus into a dilated bronchus; in the base of the lung were a number of reticulate dilatations, but no large cavity.

2. A man, aged 32, who gave a history of only six months' illness, was admitted to Hospital on Oct. 3rd, 1883, with cough, profuse expectoration, which had lately become offensive, night-sweats, shortness of breath, loss of flesh, and occasional hæmoptysis. There was bulging in the right scapular region, and below it; dulness, loss of breath-sounds and of vocal vibration, and, on Oct. 10th, a diffused friction

---

[1] Dr. Porter (*loc. cit.*) gives a case of gangrenous abscess of the lung, where, in addition to the usual signs of abscess, there was marked tympanites at the seat of the lesion, which would be removed by severe coughing, leaving an area of dulness well marked.

sound. A week later, as in case 1, the signs were changed,[1] and there was marked cavernous breathing, with bronchophony, and fine crepitations. Puncture, on four occasions, failed to find pus; and in December there was no improvement, and he was coughing daily a pint of watery, purulent, and somewhat offensive sputa. *Operation*, Dec. 23rd, the area of cavernous breathing and pectoriloquy was carefully marked out, and an incision was made over the centre of it, in the tenth space, in the scapular line. There were dense pleural adhesions. A trochar and cannula were pushed forward into the lung for about four inches, and then seemed to enter a small cavity, for air came out in puffs, and was distinctly fœtid; a probe could be passed from the cavity along a bronchus. The lung was kept drained, and the patient was much improved; the temperature fell almost to normal, good appetite, less cough, much less expectoration. He died in February, 1884, of cerebral abscess. *Post mortem*, the pleura was enormously thickened, and everywhere adherent; the lung was much contracted, and contained a number of multilocular thin-walled cavities of different sizes, continuous with dilated bronchial tubes, and containing whitish, mortary, exceedingly fœtid matter. The operation-wound led into one of the largest of them.

3. A man, aged 25, worker in a felt factory, had for four years been subject to cough, but without expectoration, till a fortnight before admission to Hospital, when he suddenly began to have profuse and fœtid sputa. There was œdema of the lower limbs, bedsore over the sacrum, night sweats, loss of flesh; signs of a cavity in the upper part of the left lung; he was going from bad to worse, in spite of treatment. *Operation*, Sept. 29th, 1892: incision four inches long, through second left space in front; pleura adherent, and of greyish tint, lung harder than natural. Attempts made with a director failed to find a cavity; the wound was therefore packed with gauze. *Second operation*, Nov. 4th, sub-periosteal resection of three to four inches of third rib, beginning about an inch from edge of sternum; a Paquelin's cautery was passed in different directions into the chest, and at the fourth attempt there came air and a quantity of fœtid fluid. Unhappily, it was thought necessary to dilate the track into the lung; and this caused profuse hæmorrhage,

[1] A similar change of the breath-sounds was noted in cases published by Dr. H. Hawkins and Dr. Alexander Morison, "Clin. Soc. Trans.," 1891 and 1893.

so that the patient was almost suffocated. The lung was immediately plugged, and ergotin was injected under the skin. He made a rapid recovery, regained his full health and strength, and was discharged from Hospital on 14th of November.

Chances of Success of Operation.

From these cases of abscess and bronchiectasis that I have quoted, we may get a fair idea of the surgical treatment of cavities of the lung not due to tubercular disease or to acute gangrene. We see that simple abscess and bronchiectasis, though they are of different origins and run different courses, are not sharply defined from each other surgically. But if we take, on the one hand, cases of large single simple abscess of the lung, and, on the other, cases of advanced bronchiectasis, where a great part of the lung is riddled with small irregular tortuous cavities, we see how different the chances of successful operation must be in these two diseases. And this difference is well shown in the following statistics published by Trzebicki in Sept. 1892, of all the cases of operations on the lung recorded up to that date :—

1.—Simple abscess of the lung: 42 operations. 14 complete recoveries, 3 recoveries with fistulæ, 24 deaths, 1 result unknown.

2.—Bronchiectasis: 12 operations. No complete recoveries, 1 not yet healed, 8 deaths, 3 result unknown.

3.—Gangrene of the lung: 24 operations. 7 complete recoveries, 1 recovery with fistula, 1 not yet healed, 13 deaths, 2 result unknown.

4.—Tubercular cavity: 24 operations. 5 complete recoveries, 5 not yet healed, 9 deaths,[1] 5 result unknown.

5.—Hydatid cyst: 45 operations. 37 complete re-

[1] One of these deaths did not occur till three years after the operation.

coveries, 1 recovery with fistula, 6 deaths, 1 result unknown.

6.—Resection of lung tissue: 5 operations. 1 complete recovery, 4 deaths.

Hofmokl's statistics (1892) tell the same story. 'As regards my own work,' he says, 'putting aside the cases of tubercular cavities, hydatid cysts, and new growths, and taking only abscess, bronchiectasis, and gangrene, I have had 80 cases. The best results, out of these three, were those of simple abscess: the worst were those of bronchiectasis, where out of 14 cases only 2 made a complete recovery after operation.'

Operation.

We need not here endeavour to estimate those signs and symptoms which guide the physician to diagnose a suppurating non-tubercular cavity in the lung, and to advise that an operation should be performed. From a purely surgical point of view, the interest of the case begins with the exploratory puncture with a suitable needle and syringe. The surgeon is very likely to fail to find anything: even if his needle does enter the cavity, the pus may be too thick to flow through it, or the cavity may be almost empty, the pus having been discharged through the mouth by a recent fit of coughing.[1] But if he does find pus, then his needle may serve two further uses: it guides him to the cavity, and, if it does

[1] In one case, of bronchiectasis *plus* localized empyema, the needle entered the cavity, but the contents of it were too thick to flow through it; and it is possible that the needle, as it was withdrawn, infected the empyema, for at the time of operation it was fœtid. In another case, the physician took care to give the cavity time to refill after a fit of coughing, before he punctured it, and was successful in finding pus. (Dr. H. Hawkins, 'Abscess of Lung,' "Clin. Soc. Trans.," 1891, p. 91.)

not oscillate with the movements of respiration, but is simply lifted up and down with the whole wall of the chest, it goes to prove that there are adhesions between the lung and the pleura. Other things may help him to feel sure of their presence; the sensation of the needle passing through thick tough tissue, the history of previous pain, or of a friction-sound, the long duration of the disease,[1] the physical signs, the contraction or limited movement of that side of the chest.

It is, of course, essential that the cavity in the lung should before incision be shut off from the pleura. In these less acute conditions, adhesions are seldom absent, unless the cavity be of recent origin, or far from the surface of the lung. But if the surgeon, having divided the soft tissues, should find the pleura not thickened, and should see the lung moving freely beneath it, he must be prepared to do something to shut off the pleura. Krimer, about 1830, operating for a cavity in the lung, found no adhesions; as soon as he opened the pleura, the lung at once collapsed, and could not be drawn forward, and the operation had to be abandoned.[2] The older surgeons advised that, if there were no adhesions, caustic should be laid to the pleura for some days before it was incised; but it is better, in accordance with more recent teaching, to suture the lung to the pleura.[3] Should there be reason to fear that any of the pus in the cavity has

---

[1] 'At any time after three or four weeks (judging from other cases of pleurisy) adhesions would be sufficiently firm.' Douglas Powell and Lyell, on 'A Case of Basic Cavity of the Lung treated by Paracentesis.' "Med. Chir. Soc. Trans.," 1880, p. 333.

[2] It is to be noted that the collapse of the lung emptied the cavity, the pus flowed freely through the patient's mouth, and he was for a time relieved.

[3] For references to this, see Chapters XX. and XXI.

found its way into the pleura,[1] an incision ought at once to be made low down into the pleura, and free drainage provided.

There is no one method of reaching the cavity in the lung. Some surgeons prefer the Paquelin's cautery; others a director, or the knife, or a trochar and cannula; the right method must depend on the depth and vascularity of the lung-tissue over the cavity. Many instruments have been invented for opening a track through the lung with a maximum of accuracy and a minimum of danger; one of the best of them is a fine director fitting close round the needle of an exploring syringe, as a cannula fits a trochar, so that needle and director enter the lung together, and when the needle is withdrawn, the director is left behind as a guide. This instrument seems to me better than one which I had made for me some years ago—a long, sharp-pointed, deep-grooved handleless director, the same size all along, graduated in half-inches, with a set of tubes of different lengths to slide over it. Whatever instrument is used, the surgeon must go slowly; he must be very careful how he dilates the track; he must be content, if there be much bleeding, to plug the wound in the lung rather than risk the life of his patient by letting blood pour into the air-passages.

There is no need of a long list of cases, to illustrate all the doubts and difficulties that attend the surgical treatment of a suppurating non-tubercular cavity of the lung. The surgeon must, in the common phrase, look at the

[1] This accident has in several cases proved fatal. It may occur even though there are adhesions. Thus, in one case where a small cavity was opened and drained, the patient was found, three days after the operation, to have a general empyema, 'doubtless owing to disturbance of the pleural adhesions during the necessary manipulations.' It was at once opened and drained. The patient made a complete recovery.

case all round; remembering that a cavity near the apex[1] may drain into the bronchi, and may thus be healed without operation, but one in or near the base cannot; and that his chance of permanent success is small indeed if the cavity be only part of a widespread bronchiectasis. But, even in these cases, he must interfere, if the patient be steadily losing ground, and in danger of death from septic absorption, or infection of the opposite lung, or breaking of the cavity into the pleura. He must remember that the disease of the lung may be combined with a purulent pleural effusion. He must find adhesions, or must shut off the pleura. If there be a large cavity, traversed by bridles of fibrous tissue, he must leave these, and not break them down, lest he should provoke hæmorrhage. Finally, he has the encouragement of a long record of successful cases: and yet it is less than twenty years since Trousseau[2] laid down the rule that an abscess of the lung was altogether beyond the reach of surgery.

---

[1] A very valuable case of abscess near the apex of the lung, appearing to open into the posterior mediastinum, has been recorded by Dr. Alexander Morison, "Clin. Soc. Trans.," 1893; Mr. Bryant reached it through the third intercostal space, between the spine and the scapula.

[2] 'Une fois l'abcès formé, notre intervention ne saurait avoir prise sur une affection de cette nature, placée tout à fait en dehors de nos moyens d'action.'—"Clinique Médicale," 1877.

CHAPTER XX.

GANGRENE OF THE LUNG.

It is not possible, for the purposes of this book, to keep gangrene wholly separate from other diseased states of the lung. Bronchiectasis, fœtid empyema, sloughing of the bronchial glands, foreign bodies in the bronchi, are all so closely related to gangrene of the lung that it can hardly be considered apart from them. It arises under many different conditions, and runs a very uncertain course. It often presents great difficulties of diagnosis, and even those cases that require operation may pass beyond the reach of help without ever having given clear indications for surgical interference.

Many, again, never come within the range of surgery. Gangrene of the lung, from severe crushing of the chest, or from a mass of malignant disease compressing the pulmonary vessels at their origins, is more likely to be diffused than to be circumscribed; and that form of it also which occurs in diabetic, insane, or alcoholic patients, usually ends in death without becoming circumscribed. Obstruction of the main bronchus near its origin, and infection of the whole lung by the entry of septic matter into the air-passages, tend in the same way either to diffuse gangrene, or to the formation of a gangrenous cavity so deep in the lung as to be almost inaccessible.

Simple acute pneumonia, in a patient otherwise healthy, very rarely leads to gangrene; but septic pneumonia, or inflammation of the lung in those who are in feeble

health, or reduced by some chronic disease or by drink, sometimes ends in gangrene involving perhaps a whole lobe of the lung. Andral, in 583 *post mortem* examinations, in cases of pneumonia, found gangrene in 52, or 3·3 per cent. Huss, in 2,166 cases of pneumonia, met with only twelve instances, in men from 35 to 55 years old, every one exhausted in health. Dr. Charles West says that the lung in childhood shows a much greater tendency to pass into a state of gangrene than in adult age; but this is not seen in the acute pneumonia of children, and instances only occur singly in the works of different authors. Ziemssen met with it only once in 201 cases of primary pneumonia in children.[1] Hæmorrhage into the lung-tissue, pulmonary apoplexy, may be followed by gangrene, and this is more likely to be circumscribed than diffused. But the cases where we have most reason to hope that the disease is both circumscribed and superficial, are those where it is due to a minute embolus blocking one of the terminal branches of the pulmonary artery, as in those published by Trousseau, and by Dr.

---

[1] These figures are given in Dr. Wilson Fox's article on Pneumonia, in Russell Reynold's "System of Medicine," 1871, vol. iii., p. 672. He says, 'Gangrene after pneumonia is very rare; still, some well-authenticated instances are recorded, and it appears that an epidemic influence may at times predispose to its occurrence. Hughes ("Guy's Hospital Reports, 1848") found 28 cases of gangrene in 200 *post mortem* examinations of pneumonia. At one time, it was noted that several cases of gangrene appeared during the prevalence of an epidemic of influenza, and that as many as six cases occurred in one week. It commonly appears late in the disease, but it has been seen as early as the fifth day. In fifty-three cases of which I possess observations, I have found two instances of gangrene, and in both these it was irregularly diffused through scattered spots of pneumonic infiltration. Its site, according to Huss's observations, is most commonly in the lower lobe, and it has almost invariably occurred in exhausted constitutions. In tubercular pneumonia, it is much more common.'

Cayley with Mr. Pearce Gould.[1] In one, embolism was due to phlegmasia dolens of the leg; in the other, to caries of the mastoid.

Unhappily, where there is one embolus, there may be many; and the surgeon may reach one focus of the disease and leave the rest. Or there may be only one embolus, but this so large that a great part of the lung perishes. Or the gangrene, circumscribed for a time, may later become diffused; or, even after operation, it may continue to spread.

Then, again, the difficulties of diagnosis may be almost insuperable. They may be gathered, some of them, from the following cases[2]:—

1. A woman, aged 23, was attacked by bronchitis, with fœtid expectoration, in November, 1880. In December, there were signs of solidification of the upper lobe of the left lung in front, with tenderness on percussion, but no redness or swelling. On January 4th, 1881, there were signs of pleurisy over the left base; and, about the middle of the month, percussion over the fourth left space gave a cracked-pot sound, and gurgling was heard here; the pleurisy was diminished. Exploratory puncture in two places drew off two kinds of fluid: above and in front, it was purulent and fœtid; below and behind, it was clear and serous. It thus appeared that there was a gangrenous cavity, with pleural effusion, and a barrier of adhesions between them. The puncture into the cavity left a fistulous track, and the patient's condition remained bad: on January 24th, the cavity was freely incised, and a few ounces of fœtid pus let out. Slight hæmoptysis occurred that evening, and again a few days later. She made a complete recovery.

2. A patient, after pneumonia, had empyema, and underwent the usual operation; but his temperature remained high, and no reason for this could be found, till the surgeon

[1] Trousseau, vol. v., p. 320. "Med. Chir. Soc. Trans." 1884, p. 209. See also Mr. Silcock's case, Embolism from heart disease, "Path. Soc. Trans.," 1886.

[2] Bull, 1881, quoted by Truc; Krecke (1891), and Thue (1891), quoted by Heydweiller; Koch, "Deutsch. Med. Wchnschr." 1882, p. 440.

one day, changing the dressings, saw a dark mass in the wound; this was easily removed, and was a piece of lung-tissue more than two inches long and an inch thick. Improvement at once, and complete recovery.

3. A man, 37 years old, after an attack of acute general bronchitis, was found to have serous effusion in both pleuræ. This was followed by a circumscribed patch of gangrene in the anterior upper part of the right lung. Pieces of the third and fourth ribs were resected, and the lung, which was adherent only here and there, was stitched to the chest-wall. The gangrenous cavity was opened with a Paquelin's cautery; no irrigation was employed. For four weeks, the patient did well, and was free from fever, then came an empyema, on the same side as the disease in the lung: this, too, was successfully treated, and he made a good recovery.

4. A man, 24 years old, who had suffered synovial disease of the knee joint in his boyhood, and gone through 'a series of pneumonias,' began, in 1878, to be troubled with profuse expectoration, shortness of breath, loss of flesh, and severe night-sweats. In 1882, there were signs of chronic bronchitis about the upper lobe of the right lung, and of a cavity in its lower lobe, with pleural effusion; the sputa were gangrenous. After puncture, on two occasions, for the relief of the effusion, part of the sixth rib was resected, on June 24th; the lung was incised with a Paquelin's cautery, and a cavity was opened, about the size of a hen's egg, lying three fingers' breadth from the surface. A week later, as the expectoration was still profuse, a piece of the eighth rib was removed, and the cautery was passed 5½ inches into the lower lobe of the lung; it opened only some small bronchial dilatations. Further exploration with a Pravaz syringe, drew off some fœtid sero-purulent fluid, but no cavity was found anywhere. On July 11th, a third operation was performed, and the lung was explored through the eighth space, between the scapula and the spine, but still without success.

These four cases show only a part of the difficulties that may attend the diagnosis and treatment of gangrene of the lung. It is pleasant to turn to the statistics of operation for its relief. The deaths from the disease left to itself may be put at 75 or 80 per cent; and, although it is of course only the more favourable cases that come to operation, yet the saving of life by it is

past all dispute. Truc gives 13 operations (1879–1884): 3 patients were cured, 2 relieved, 2 were on the way to recovery, and 6 died. Hofmokl (1892) gives 24 operations, all his own, with 7 cures; and Heydweiller gives 40 (1879–1892) with 22 cured, 4 improved, and 14 deaths. The figures for the last few years are better than those for the years before them. Reclus gives 14 operations (1885–1895), with 11 cured, 1 improved, and only 2 deaths. It would be hard to find a more vivid instance of good surgery.

Supposing that a case has been rightly diagnosed as one of gangrene of the lung, circumscribed, accessible, we have next to consider the question, Shall the operation be done at once, or can any advantage come of waiting?

Three reasons are given why the surgeon should wait for a time, so long as there are no marked signs of septic absorption. The first is, that he must not operate till the gangrene has passed the stage of consolidation, and become deliquescent; the second, that he must be sure that adhesions are present; the third, that some cases get well of themselves. Now we may admit that if ever the surgeon finds a case of gangrene of the lung where there are no signs of septic absorption, that case may get well of itself; but such a case is not likely to occur. As for the stage before deliquescence, the diseased tissue has probably deliquesced long before its existence was diagnosed. The presence of adhesions is of very great importance; but even if they be absent, the operation may yet be successful, as we see from the third case of those just quoted, and from Krause's case given in Reclus' paper, in the Appendix to this book. And, if the surgeon waits, the disease may become more diffused, or may break into the pleura; as in a case of Hofmokl's, a man, aged 30, a drunkard, who, after acute pneumonia, a month

before admission to Hospital, had gangrene of the upper lobe of the right lung, which broke into the pleura. Incision in the sixth space, in the axillary line, let out no less than seven pints of fœtid pus. He died of exhaustion, a fortnight after the operation.

Given then, clear signs of a gangrenous cavity in the lung, as accurately localised, by careful examination, as is possible, and not drained by the air-passages, by what method shall the surgeon operate? He must, of course, make an exploratory puncture; and he had better be prepared to follow this at once by operation, if he find pus; though I do not know of any case of gangrene where puncture with a fine needle has infected the pleura. His incision must be free, and he must not hesitate to resect a piece of a rib, or even of more than one rib, if the cavity be of great size. But many cases of recovery have been recorded after simple puncture of the cavity with a large trochar and cannula, followed by drainage. At all events, there is no clear evidence in favour of the 'preliminary Estlander's operation,' which is advocated by one or two surgeons as the first step toward opening and emptying a large cavity in the lung.

Of the importance of finding or establishing adhesions, something has already been said in the chapter on 'Abscess of the Lung,' and more will be found in Reclus' paper. If the question be not determined by the oscillation or non-oscillation of a needle passed into the lung, the surgeon may settle it by carefully exposing the pleura without opening it. If it be thin and half-transparent, and the lung be visible moving up and down beneath it, there are no adhesions. He must then, if the case be not very urgent, fasten the lung to the pleura, and wait a day or two (Reclus says five days at least) before opening

it. But if he cannot wait, or cannot secure the lung to the pleura without opening the latter, he must do this, and stitch the two together, as in operating on the liver.

Roux's method of suture, 'à arrière-point,' is best described in his own words.[1]

"Having incised the intercostal muscles, exposed the pleura, and seen the lung moving freely beneath it, I sutured the two layers of the pleura together, all round the wound, catching up the lung tissue with a curved needle as, during each inspiration, it came forward into the wound. But instead of simply putting separate points of suture here and there, and thus leaving gaps which might admit air, I did what the women in my part of the country call 'suture à arrière-point': the needle is passed through the pleura, picks up the lung, and comes out again through the pleura; then it is put through again, between the points of entrance and of exit, picks up the lung again, comes out in front of the first point of exit, and so on: thus you get a continuous suture all round, and finish by tying its two ends together. It keeps the two layers of the pleura in perfect apposition, and yet there is no dragging on it; so that you avoid the little lacerations and gaps that you get with an interrupted suture. I used it six days ago, in a case of cavity in the apex of the right lung in front, not adherent, and opened the cavity at once. It has held perfectly; not a bubble of air has entered the pleura, the patient has lost his fever, and is already able to leave his bed."

If the surgeon, having got down to the pleura, should find no adhesions, he may yet learn something by feeling the lung through it without opening it. The following observation by Tuffier[2] is of interest, but the manœuvre needs practising on the dead body.

"I had occasion not long ago to find out the practical value of stripping the parietal pleura off the ribs. The case was one of gangrene of the lung. I made my incision over

[1] "D'un nouveau procédé applicable aux interventions sur le poumon." Roux (de Lausanne), Soc. de Chir., Paris, June 17, 1891.

[2] "Semaine Médicale," 1891, p. 202.

the place where the physical signs of a cavity had been observed, and resected a piece of the eighth rib, and then loosed the pleura from the ribs over an area of four or five fingers' breadth. It was easy to palpate the lung through it, and I could feel nothing abnormal anywhere. I therefore went on loosing the pleura off the ribs, and at last I made out an area of induration in the lung, and gained easy access to it by further resection of the rib. At this point there were adhesions. I made my incision through the pleura here, opened the cavity, and let out a quantity of pus. I washed and drained the cavity; the temperature came down, and the patient is doing well. In cases of this kind, therefore, if you don't come straight down on the disease, you can, I think, by thus raising the pleura off the ribs, find the gangrenous focus without opening the pleura to do it. You must begin working at the pleura in an intercostal space, as it is looser here than at the upper and lower borders of the ribs.[1]

If the surgeon, after the cavity has been accurately localized before operation, should yet be in doubt as to the exact point, to an inch one way or the other, where to place his skin-incision, he should remember that the disease tends to track downward, and that he had better go too low than too high. Not that it matters much, so far as the healing of the cavity is concerned, where it is opened; for it is healed by a sort of concentric process of contraction; but if he cannot be sure of hitting the centre of the cavity, he had better, in view of the downward tendency of the disease, be below this point than above it.[2]

---

[1] We must note that this 'décollement' of the pleura was used by Tuffier in his case of resection of the apex for tubercular phthisis. Trying it on the dead body, I find that one must go very slowly, keeping the back of one's finger toward the pleura.

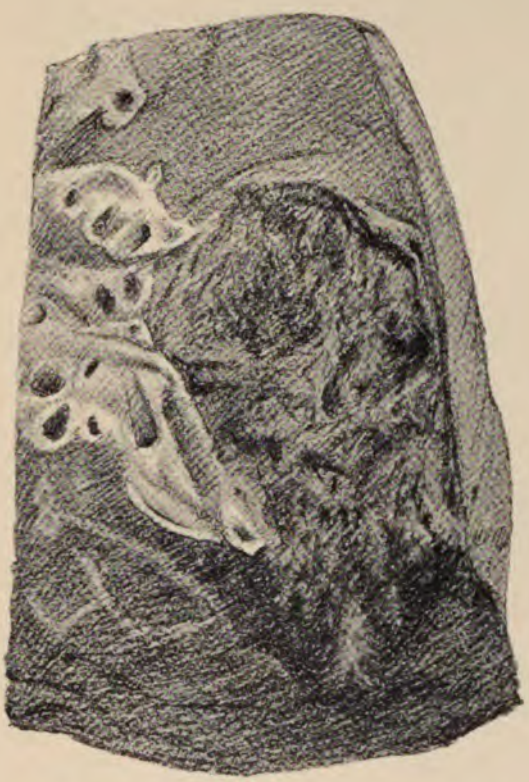
[2] 'The gangrenous patch is generally considerably below the level at which the signs of a cavity are found . . . . . I wish to point out the rapidity with which the gangrenous process extends downward from the cavity at the root of the lung (in suppuration of the bronchial glands), and hence the necessity for an opening low down.' Voelcker: for reference see chapter on 'Inflammation of Bronchial Glands.'

The method of opening the cavity must depend on the depth at which it lies. The cavity may be superficial as in *Plate* IX., and may be incised without risk of hæmorrhage. But if it be in the depths of the lung, from evidence given by the physical signs and by exploratory puncture, it is safer to use a Paquelin's cautery, advancing very slowly through the lung-tissue. There are, of course, advantages in a free opening into the cavity; but good results have been obtained by the use of the trochar and cannula alone. It was successful in the following case,[1] perhaps the deepest cavity on record.

A woman, aged 23, during the extraction of some stumps of teeth, in February, 1887, let one of them slip into her air-passages, and a few days later began to have a troublesome cough, with slight muco-purulent expectoration. This went on for four months, and she gradually lost strength. By June she was feverish, sleepless, with paroxysms of cough lasting several hours; sputa offensive and very profuse; coarse râles over central part of right lung, some dulness at its base, some tenderness on percussion in front. By July, she was exhausted with incessant cough, hectic fever, bed-sores, aphthous ulceration of the mouth: two or three pints of fœtid pus were coughed up daily, it ran from her mouth during sleep, and particles of cartilage and lung-tissue were found in it. Amphoric breathing, with metallic tinkling, was heard toward the centre of the lung, over a space of more than four square inches. *Operation*, July 18th: the needle of an aspirator was pushed its full length into the chest, through the ninth space, an inch behind the axillary line, and found pus. It was withdrawn, and a large, curved trochar and cannula were passed in the same direction, upward and forward toward the sixth space in front, and fœtid pus flowed in great quantity. A drainage-tube was passed down the cannula, and was not withdrawn till the thirty-second day. The patient recovered completely. 'The pus was not reached until about seven inches had been traversed by the trochar; and there had been no pleurisy capable of gluing the two surfaces together. Both auscultation and percussion

[1] Dr. Strange, "Brit. Med. Journ." 1887, p. 1145.

PLATE IX.



Gangrene of the Lung; a large superficial circumscribed cavity, in need of operation. (From a specimen in the Royal College of Surgeons' Museum.)

pointed to the presence of a considerable layer of sound lung between the pleura and the abscess-wall, which layer was at least several inches thick. The absence of bleeding at the operation, and of effusion of air or pus into the pleural cavity, I attribute to the resiliency of the healthy portion of the lung, and the pressure exerted by the closely-fitting piece of elastic tubing which was inserted immediately after the pus had been evacuated[1].'

The next two cases[2] relate to the removal of the gangrenous tissues: the first of them is also an argument in favour of free incision. As to removal of the walls of the cavity, Delagenière, who reported the second case, admits that he does not find any evidence that it is much bettter than simple free incision.

1. A man, aged 63, a year after acute bronchitis, which left a persistent cough, began to have purulent expectoration; then came sharp pain in the upper part of one side of the chest, in front; dulness, loss of vocal vibration down to the third rib, breath-sounds feeble, blood-stained sputa. A month later, a painful spot was noted beneath the clavicle, and this was followed by fluctuation and emphysema. Incision here let out fœtid air and pus from beneath the pectoral muscle; a small opening was made into the chest, admitting a drainage tube. No improvement; two months later, his condition seemed hopeless. The wound was now laid open, a piece of the third rib was resected; the upper lobe of the lung was found to be gangrenous, and the whole of the apex was scraped away with the finger and the handle of the

---

[1] We may contrast with this case what Hofmokl (1892) says of one like it. 'In a case of gangrene of the lung from a piece of bone passing into the bronchus, I abstained from operating, because it was impossible exactly to localize the foreign body, and because there was a considerable thickness of healthy lung-tissue around the disease. There would have been hæmorrhage (as the *post mortem* examination showed), which would have prevented our finding the foreign body. Yet it is possible that even if free incision of the lung failed to find it, the foreign body might at a later period be discharged or removed along the track of the drainage-tube.'

[2] Drinkwater, "Lond. Med. Rec.," May 15, 1884. Delagenière, "Cong. Franc. de Chir." Paris, 1892.

scalpel. Drainage and irrigation were used, and a tube was kept in for six months. Complete recovery.

2. A man, aged 37, presented the signs of a large gangrenous cavity at the base of the left lung. A very extensive operation was performed, with a long curved incision, and subperiosteal resection of eighth, ninth, and tenth ribs, from their angles to their cartilages; the incision through the pleura, along the line of the ninth rib, was six inches long. A large cavity was laid open, between the diaphragm and the gangrenous lower lobe of the lung, and fifteen or sixteen ounces of fœtid pus and *débris* were let out. The whole gangrenous portion of the lung was removed with forceps and scissors, and a cavity, the size of one's fist, was left; this was carefully cleansed and irrigated. Drainage for a month; complete recovery in six weeks.

Counter-opening has been made in a few cases, and it is certain that the cavity should be very freely drained, as blocking of the tube, and retention of septic *débris*, have been noted in more than one case. And the drainage should, as a rule, be kept up for many weeks, or even for months, till it is certain that the cavity has closed. Irrigation has been used in nearly every case. In one or two it has caused troublesome cough or slight hæmoptysis, and one or two more have done very well without it; but the weight of evidence is in favour of it. But I do not think it should be done immediately after the operation, while the patient is still under the influence of the anæsthetic.

Finally, there are cases where the operation failed; but we must note that an apparent failure may yet be successful, as in the following instance[1]:—

A girl, 8 years old, after necrosis of the left mastoid from scarlet fever, had symptoms of gangrene of the lung, and finally gave signs of a large cavity at the base of the right lung. An aspirating trochar and cannula were passed in-

[1] Dr. Cayley and Mr. Pearce Gould. A case of gangrene of the lung, following necrosis of the temporal bone. "Med. Chir. Soc. Trans." 1884, p. 208.

ward and upward, through the eighth space about an inch outside the angle of the rib. A few drops of fœtid pus came out, and air passed in and out with the movements of respiration. A large trochar and cannula were then passed in the same direction, but there was no further escape of either pus or air. A drainage tube was inserted; next day, a little fœtid pus came through the tube, and air passed out on expiration. Next day, the dressings were soaked with fœtid pus, and a slough of lung-tissue was found in the tube. For some days, the discharge was profuse: the tube was removed very early, eighth day. She made an uninterrupted recovery.

The real failures seem due mostly to delay before the operation, or to ultimate extension of the disease in spite of it. In one case, the gangrene reached the chest-wall, spread far and wide among the muscles, and thus brought about death. In another, the patient died of cerebral abscess. I can find no record of entire failure to find the disease at the time of operation. There is no need to quote a longer list of cases: those given are enough to show that the risks and difficulties of the operation are not to be compared with the saving of life it has achieved.

Dr. Perry ("Path. Soc. Trans.," 1893) has recorded a case of death from hæmorrhage from gangrene after pneumonia. The patient, a man aged 45, died the day after admission to Hospital: 52 ounces of blood were found in the pleura.

CHAPTER XXI.

TUBERCULAR PHTHISIS.

It is difficult to estimate the results of the operations that have been done in these cases. So far as I can see, it is not fair to say that the successes have been published, but not the failures[1]; on the contrary, the list of the unsuccessful operations is a very long one. It would be just as reasonable to observe that many phthisical patients have died unrelieved, whose sufferings might have been alleviated if the surgeon had been allowed to operate upon them. Nor are these methods now advocated with any excess of commendation; indeed, the tendency is toward retreat rather than advance. I shall only attempt to give some account of what has already been done in this field of surgery here and abroad, and to show how little hope we have at present of doing better.[2] But we must remember that even to relieve the suffering of the last few weeks of phthisis is itself a successful operation, and that there is no real difference between saving life and delaying death; and it seems to me that Reclus is

[1] For example, nothing could be more unfair than Bouchut's bombastic condemnation of the operation in the Hastings-Storks case (1844): 'A reckless physician or surgeon is much the same all the world over, whether in France or in England; so soon as they have begun to grasp some audacious idea, they make haste to publish the first bulletins, leaving to others the work of hiding the last bulletin in the dust of the grave; and thus they hope, but in vain, to advance themselves, cheat science, and hoodwink the profession.'

[2] The references to experiments, and to some of the operations, are from Truc and Reclus

inclined to undervalue the alleviation of distress that may be gained in some of these cases by surgical treatment.[1]

The methods of surgery possible for tubercular phthisis are five in number: Injection of fluids into the lung-tissue; operation for pyo-pneumothorax with perforation of the lung; operation for the arrest of profuse hæmoptysis; resection of the apex of the lung; and incision of a tubercular cavity. We may take these five subjects in this order, and follow the evidence for and against each of them.

1.—Injections into the Lung Tissue.

This treatment of tubercular phthisis has received a fair trial during the last ten years; but I believe it has never found favour in England. The experiments which preceded it showed clearly that it is possible by this method to cause wide-spread cicatricial changes in lung-tissue without doing harm. Twenty years ago, W. Koch and König made numerous injections of sodium iodate and of iodine into the lungs of animals, and were able, without any bad results, to convert large tracts of the lung into cicatricial tissue. In 1882, Fränkel tried many different substances—alum, carbolic acid, boracic acid, iodoform, but without any very marked results; in 1885, Truc and Lépine used creasote, corrosive sublimate, and

[1] 'Picture to yourself that most distressing condition, the final stage of chronic phthisis. See your worn and attenuated patient, longing for sleep, tossing restlessly from position to position, struggling incessantly with a cough that sets rest and repose perpetually at defiance; see the reeking transparent skin, the saturated hair, and the piteous expression of weariness and utter exhaustion—and say whether such relief as might be obtained from an outlet, through which all this horrible corruption might be extruded, might not be worth the additional risk of even a somewhat serious operation.'—Wheelhouse, "Brit. Med. Journ.," 1887, ii., 1141.

alcohol, and with these produced more definite inflammation and exudation, without suppuration or bad effects of any kind.

But what is the evidence as to the practical value of this method for the relief or cure of a phthisical patient? We may best answer this question, if we first consider the general objections that are opposed to it, and then take the experience of those who have made a fair trial of it.

Certainly this treatment by injections, if we are to accept it, must win acceptance by its own merits, and must stand the test of practical use; for there is nothing else to commend it to us, and it is a way of working in the dark which recalls Voltaire's accusation against the physicians of his own day, that they were putting drugs of which they knew little into bodies of which they knew less. The number of the remedies that have been tried—permanganate of potash, carbolic acid, salicylic acid, iodine, nitrate of silver, creasote, perchloride and biniodide of mercury—shows that the right one is still not found; nor do we know how far the desired result is simple scarring of the diseased lung tissue, and how far it is the arrest or destruction of the bacilli themselves. To expect to do much for phthisis with a few drops of antiseptic fluid, driven haphazard once or twice a week into a lung which we know to be tubercular, but cannot know the exact extent and distribution of the disease, is surely to ignore the plain teaching of pathology[1]. We are told that the whole hope of this method

[1] 'Let me draw your attention to one point concerning injections into the lung-tissue in cases of tubercular phthisis. Pulmonary tuberculosis, with its multiple scattered foci of disease in a vital organ, is the worst possible field for this kind of treatment. In local tuberculosis of peripheral, easily accessible tissues, such as the skin, the bones, and the joints, we have of

is in getting the case at an early stage of the disease; but we have no clear evidence that even thus the injections are of much value. And when we consider that those who suffer from phthisis are apt to hope against hope, we shall find reason to discount the improvement which they have noted in themselves after this treatment.

What then, apart from theoretical objections, is the actual result of this method in practical use? We are not here concerned with the treatment of phthisis by hypodermic medication,[1] but with the injection of fluids into the diseased area of the lung. Can we find any records of success to contradict the unfavourable opinion given in the latest English text-book on this subject?[2] I have not found anything of the kind, and there are plenty of instances of failure, and of harm done instead of good. The worst results have come from the use of the biniodide of mercury, as might be expected; it has caused acute suppurative bronchitis, ending in death in 24 hours, acute pleurisy, and other troubles. Riva[3] had a case of fatal cerebral embolism, occurring during the

---

course the best opportunity for the local application of germicidal remedies. Prove the efficacy of your substances first on these parts of the body, before you go on to experimenting on the lungs with them.'—Penzoldt, "Verhandl. des Congr. f. Inn. Med.," 1885-6, p. 58.

[1] A full account of this treatment is given in Harris and Beale's recent work, "The Treatment of Pulmonary Consumption," London, 1895. They draw attention to the good results obtained by Opitz (1889) from the use of balsam of Peru, and by Roussell (1888) from eucalyptol.

[2] 'We may say that so far no results sufficiently good to justify the great discomfort, which is certain, and the risk of fatal complications, which is possible to result from these injections, have been recorded.' Harris and Beale, *loc. cit.*

[3] For reference, see Heydweiller's excellent inaugural dissertation "Ueber Lungenchirurgie," Berlin, 1894.

injection. Lesser troubles are of frequent occurrence; For example,[1] 25 injections of creasote, divided among 15 patients, gave rise to the following long list of slight disturbances; in 5, slight pain; in 5, severe pain; in 2, severe cough; in 3, a slight touch of pneumonia; in 4, slight emphysema; and in 6, slight fever. Serious troubles are rare: for example, Pepper, of New York (1885) made 282 injections among 17 patients, without a single disaster of any kind; but also without any very marked results. One looks in vain for any list of cures; there are plenty of cases of slight improvement, and that is all. Of course it is possible that if this treatment were more generally used, and limited to cases in the first stage of the disease, some more definite measure of success would be gained; but as things are at present we can hardly desire that it should be kept from falling into oblivion.

2.—Operation for Pyo-pneumothorax with Perforated Lung.

This subject has been already mentioned in the chapter on 'Empyema'; and here we have to consider it again, on account of a few recent operations which have gone so far as to expose and suture the perforation in the lung. The state of the pleura, in tubercular phthisis,

[1] Truc's cases. He used a solution of creasote in alcohol, 1 in 25, or 1 in 50. Most of the patients had only one injection; some had two, three, or four, at intervals varying from a few days to several weeks; the injection was made very slowly, through one of the first three intercostal spaces. Immediately after it, the physical signs were certainly changed, but in a few days they returned to their former character. Some of the patients felt better after the injections—less cough and expectoration, better sleep and appetite. He gave relief in a few of the cases, in the early stage of the disease; he did not in a single advanced case check its ordinary course.

ranges from slight adhesions, which are always present,[1] to fœtid pyo-pneumothorax soon causing death; and West has shown that 5 per cent. of the deaths from phthisis occur soon after the onset of pneumothorax, mostly within a fortnight. It is evident that one must not by vigorous aspiration break down the adhesions which limit the disease, and thus convert a simple and almost harmless serous effusion into something much worse; and there is a good deal to be said in favour of leaving these effusions alone, so long as they cause no serious pressure, and no septic absorption; and if the effusion is altogether subordinate to extensive advancing tubercular infiltration of the lung, a partial removal of it may be safer than any more active treatment.

But if the condition of the pleura is the worst part of the case, if the patient is suffering from a large fœtid pyo-pneumothorax, and shows signs of septic absorption over and above those that may be referred to the disease in the lung, then surgery may do something to ease his distress and prolong his life. And the question has

---

[1] 'So common are pleuritic affections in phthisis that a *post-mortem* examination which did not reveal the presence of adhesions in some part or other of the pleura would be almost a curiosity; in the records of 100 *post-mortem* examinations on cases of phthisis, taken at random from the books of Victoria Park Hospital, adhesions were present in every case . . . Effusion is by no means a common occurrence in phthisis; out of 100 cases taken from the *post-mortem* records of the same Hospital, in 9 only was there effusion, apart from pneumothorax; in two of these, the fluid was blood-stained, in the others it was clear; and in association with pneumothorax there were seven cases of effusion, 1 purulent, 1 clear, 3 turbid, and 2 blood-stained. . . . In the large majority of phthisical cases, in which pneumothorax takes place, some amount of fluid effusion ensues; and the presence of tubercle bacilli may often be demonstrated in it. It is usually milky or semi-purulent in appearance, but rarely serous; in some cases pus may be very soon poured out, and this may become offensive.'—Harris and Beale, *loc. cit.*

lately been raised, whether the surgeon would be justified in attempting, instead of simple incision, to expose the lung freely, in the hope of being able to close the perforation in it.

In 1893, Dr. Guermonprez, of Lille,[1] thus operated on a boy, aged 18, who, after pleurisy, had pyo-pneumothorax, with perforation of the lung; but it does not appear that he was suffering from phthisis. Resection of the seventh rib gave free access to the fistulous opening in the lung; and it was closed, without any refreshing of its margin, with catgut sutures. The operation was perfectly successful.

Last year, Dr. Marchant, of Paris, and Dr. Delagenière, of Mans, reported the three following cases[2] :—

1. A man, long suffering from phthisis, was admitted to Hospital, on July 14th, 1895, with pyo-pneumothorax of the right side, not fœtid, which had already been punctured seven times in the last eight weeks. His breathing was distressed, and he was feverish, and altogether in a very critical state. *Operation*, under ether; a large U-shaped flap of skin and muscles was raised on the outer and posterior aspect of the side of the chest, and about three inches each of the fifth, sixth and seventh ribs were removed; the pleura, which was nearly half an inch thick, was cut away very freely, and between five and six pints of pus were let out. The lung was found shrunken and packed away against the spine. On its outer aspect, at the junction of its middle and lower thirds, was a small round opening; an attempt was made to draw the lung forward and thus to reach and suture the opening, but the lung did not move, and was so friable that no traction could be made on it. The huge cavity was lightly packed with salol gauze, and drained. Three days after the opera-

[1] See "Wien. Med. Wchnschr.," 1893, p. 113. It was observed that the opening in the lung was widened at the end both of expiration and of inspiration.

[2] See discussion at the end of M. Réclus' paper. Reference is also made here to a similar operation, unpublished, performed last year by M. Delorme.

tion, air could still be heard passing from the lung into the cavity; but on the sixth day this had ceased, and the opening in the lung remained closed. In October, there was still a discharge from the wound, and the patient was weak and emaciated.

2. A man, aged 45, suffering from phthisis, was admitted to Hospital on Dec. 10th, 1894, with a purulent effusion into the right pleura, which on Dec. 31st broke into the air-passages. He now began to cough up enormous quantities of fearfully fœtid pus, and was going rapidly from bad to worse: absolute dulness over the lower two-thirds of the right lung, behind and in the axillary line; signs of softening of the left apex; constant fever, extreme dyspnœa, general condition almost hopeless. *Operation*, Feb. 22nd, 1895, under chloroform; a large U-shaped flap of skin and muscles was raised in the axillary line, from the fifth to the tenth rib. Resection of three or four inches each of the sixth to ninth ribs, beginning at the ninth and working upward; free opening into the pleura, disclosing a cavity the size of two fists, extending forward to the anterior axillary line, backward to the spine, and upward out of reach of the finger. Two perforations were found in the lung, both on its exterior lateral aspect, one in its upper half, the other at its base[1]: the latter was scraped and sutured, the former was out of reach of treatment. An attempt at irrigation caused such coughing and choking that it had to be abandoned; the cavity was packed with gauze. The fever disappeared, the sputa became less, and were no longer fœtid; he slept and ate well. The perforation that was not closed at the operation was healed ten days after it; air was no longer heard passing into the cavity. 'To see him to-day (Oct. 22nd, 1895), though he is still phthisical, you would fail to recognize the moribund patient on whom I operated last February.'

3. A man, aged 28, was under treatment in 1892 for acute bronchitis, and later for tubercular phthisis. In June, 1893, he was seized with dyspnœa and profuse flow of pus by the mouth; and these attacks occurred at first once a week, and afterward every five or six days. The left lung seemed almost healthy, but there was a large cavity in the right lung, beneath the clavicle, and an enormous effusion (pyo-pneumothorax) in the right pleura. *Operation*, March 22nd,

[1] The lower one was valvular, and opened during inspiration.

1894; resection of sixth, seventh and eighth ribs, free opening of pleura along line of seventh rib. 'The lung was found adherent in front and above, but at the lower part of the adhesions was an orifice, forming a communication between the pleura and the cavity in the lung. I shut off the pleura from the lung with four catgut sutures, cleansed the pleura, and laid a drain deep down in it. The patient was so weak that I put off for the present the treatment of the cavity.' He was much improved by the operation, and refused to have anything done to the lung In June, he was still doing well: the wound was nearly healed, and he still refused to let the cavity be drained. In August, his cough was worse, and the cavity again broke into the pleura; in September he died.

Certainly we must admire the skill and accuracy of these operations; but they still compel us to ask whether we may not hope, in such cases as these, to get equally good results by methods rather less severe. To suture one perforation in a tubercular lung will not stop the formation of others; and West has found four, and even six perforations in a single case. The physical signs before operation cannot give exactly the site of the spot where the lung has given way; it is most likely to be somewhere on the lateral aspect of the upper lobe, about the level of the third and fourth ribs, between the anterior margin of the lung and the axillary line [1]; but this vague statement is not of much practical value. Anyhow, the operation must be a very serious proceeding; it must begin with a large flap and with free resection of bone.[2] And it does not appear to be absolutely necessary to suture the perforation; it may heal spontaneously, when the effusion has been let out, and the cavity drained.

---

[1] For references on this point see Marchant's paper.

[2] 'The resection of the ribs must be very free; the amount of chest-wall sacrificed must be in proportion to the retraction of the lung.'

Again, there are several recorded cases [1] where success has followed operations without free exposure of the lung. In 1885, Richardière operated on a phthisical patient with pyo-pneumothorax of the left side; the effusion was very large, the patient was in a most critical condition. Incision let out 7 or 8 pints of fluid; five years later, the patient was still alive, though the wound had never wholly closed. In 1891, Merklen published the case of a phthisical patient, aged 28, with pyo-pneumothorax, treated by punctures without any good result. He practised incision, without resection, and the patient recovered with a fistula, which finally closed. Other similar instances might be quoted.

Of course, in fœtid pyo-pneumothorax, puncture is useless: a free incision, with perhaps resection of a piece of rib, is the least that can be done. But I do not think that we have at present any clear evidence that it is right to do more than this; at all events, one may do this first, not begin by planning out a sort of Schede's operation on a man already stricken with phthisis.

3.—Operation for the Arrest of Profuse Hæmoptysis.

In 1884, Dr. Cayley published a case where, for the arrest of dangerous hæmoptysis in tubercular phthisis, he induced pneumothorax and collapse of the lung by an incision through the pleura; and though the patient soon died of the disease, yet there was reason to believe that the operation had succeeded in stopping the hæmorrhage. I have not found any record that this method has been followed in England, but Heydweiller alludes

[1] For references, see Galliard, 'Le pneumothorax des tuberculeux et son traitement,' "Médecine Moderne," March 7th, 1894.

to it.[1] It was, of course, only suggested by Dr. Cayley as a last resource; and there are insuperable objections to its use, which found expression at a meeting of the Medical Society, Dec. 14th, 1885.[2] I put these criticisms

[1] 'Toussaint, in his account of the surgical treatment of tubercular disease, suggests that the occurrence of pneumothorax in tubercular phthisis has a very good result on the disease, inasmuch as it exercises pressure on the growing tubercle, and checks the flow of blood to the lung. On the strength of this theory, some surgeons have set up artificial pneumothorax in cases of hæmorrhage from the lungs, by inflating the pleural cavity with sterilized air; but the patients died in a few hours.'

[2] Dr. Acland thought it would fail for two reasons: 1. If the lung were considerably diseased and consolidated, as it often was, then local pressure could not be brought to bear on the bleeding point; 2. If the lung were not already extensively diseased, it would be infiltrated with blood in a semi-coagulated state, and therefore, again, local pressure could not be applied.

Dr. Kingston Fowler said that Dr. Cayley had only suggested this treatment for such cases as would otherwise end fatally, and his case was of this kind. The patient, who had for some time been suffering from profuse hæmoptysis, shortly after the operation brought up a small quantity of blood; but for some days after he brought up no blood. At the *post mortem*, the lung was found collapsed at the site of hæmorrhage. He concluded that the pressure which the collapse had produced had contributed materially to occlude the vessel. In the cavity was a laminated clot, and communicating with it was a bronchus which evidently had been occluded by the operation. He thought the following objections could be urged against this operation: 1. The site of advanced disease was usually also the site of pleural adhesion, therefore the induction of pneumothorax could not bring about collapse of the bleeding tissue; 2. Unless the air introduced were aseptic, it would be likely to cause pleurisy. Acute pleurisy was found in Dr. Cayley's case; and he could not help thinking that this contributed materially to the fatal end of the case; 3. The induction of pneumothorax destroys the lung; 4. If the disease be extensive, the surrounding consolidation will prevent collapse. He thought therefore that it was very rarely that the operation could be performed; and especial care should be taken to render the introduced air aseptic.

Dr. West thought the treatment of hæmoptysis by this method was open to considerable question. He had recently seen a case of phthisis with pneumothorax, in which the air existed in the pleural cavity at considerable pressure, but nevertheless the patient died of hæmorrhage.

at full length in a note, as they show clearly that the production of artificial pneumothorax, though it may be good in theory, is not destined ever to take a place in surgical practice.[1]

Nor can anything be said for the suggestion that injections of some hæmostatic substance into the bleeding cavity may avail to stop the hæmorrhage. Those who believe in the injection of fluids into the lung say that they may be useful in cases of hæmoptysis, 'when the site of the hæmorrhage is limited, accessible, and exactly made out'; but this is what Nélaton called 'one of those indications for treatment that are invented in the library,' to which Dr. Matthews Duncan gave the name of 'fireside pathology.'

There remains a third method of surgical treatment for hæmorrhage from the lungs, and that is the old plan of venesection. In his valuable paper on 'The Treatment of Profuse Hæmoptysis' ("Medical Society's Proceedings," 1886) Dr. West points out that at least this treatment is based on sound principles; and that the cause of death in these cases is not so much loss of blood as suffocation. But here we are trespassing on purely medical subjects; still, there seems reason to believe that venesection, if we may call it a surgical method, is at least more trustworthy for the arrest of profuse hæmoptysis than either the production of pneumothorax or the use of injections into the lung-tissue.

---

[1] At the Medical Congress at Rome (1894), Dr. Forlanini, of Naples, read notes of some cases of phthisis which he had treated by making an artificial pneumothorax: not to arrest hæmorrhage, but to check the progress of the disease itself. He used oxygen, making repeated injections of small quantities of it into the pleura. The method was very tedious, and its results were not very striking.

4.—Resection of the Diseased Portion of the Lung.

Every surgeon, when he sets to work to read some small sub-division of the literature of surgery, is haunted by the certainty that he will find many things that he ought to have done, and perhaps by the fear that he will find some very arduous and dangerous operation that he ought to do. But he need not be afraid that it will ever be his bounden duty to resect the apex of the lung for phthisis. We honour the names of Lowson and Tuffier, whose operations were successful, and those of others who deserved success, but did not command it; but the indications for the operation are so doubtful, the advantage of it so uncertain, and the proportion of deaths from it so large, that at present there is no clear reason why the surgeon should undertake it.

Here again, as with intra-pulmonary injections, so with removal of a tuberculous apex, experiment gave hopes which were not fully realized by experience. In 1881, Glück ligatured the whole root of the lung in dogs and rabbits; only two of them died, the ligature having interfered with the heart or with the phrenic nerve. He then removed the whole of the lung in six dogs and fourteen rabbits, making a curved incision from the third to the sixth rib, beginning one inch from the edge of the sternum; sub-periosteal resection of third to sixth ribs, free opening of pleura, lung drawn forward, ligatured and removed; careful cleansing of pleura, wound closed. Very few of the animals died (pericarditis, purulent pleurisy); no secondary hæmorrhage, no thrombosis of the heart; seldom dyspnœa, or any serious trouble; rapid healing, in which the pedicle took active part. He also made numerous experiments on the dead body.

In the same year, Dr. Marcus, of Jassy, removed the

whole lung in two dogs and three rabbits. The dogs died, one under the anæsthetic, the other of purulent pleurisy; the rabbits died on the third, sixth and twenty-seventh days; no troubles of the circulatory system; on several occasions, intense dyspnœa, stopped at once by occlusion of the wound.

In 1882, Block made numerous experiments on rabbits, dogs, pigs, and cows, some healthy, some tuberculous; but these, most of them, were not resections of the whole lung. He obtained excellent results: the pneumothorax was of short duration, and the lung after the operation expanded well and remained active.

In 1881, Schmidt made several resections of part of the lung, using a temporary ligature for the arrest of hæmorrhage during the operation. A strict antiseptic method was not followed; three of the animals recovered, four died of purulent pleurisy, one of carbolic acid poisoning. No secondary hæmorrhage.

In 1882, Biondi made numerous experiments on cats, dogs, sheep, and other animals. His results were very good, as the following table shows:—

	Operations.	Recoveries.
Removal of whole of the right lung ...	23	12
" " " left lung ...	34	18
" " " both apices ...	3	3
" " " middle lobe ...	1	1
" " " lower lobe ...	1	1

and he attributes the failure of some of his operations wholly to imperfect use of antiseptics before, during, or after them.

Unhappily, the records of surgery tell a different story; and it is said that one among those, whose names I have just mentioned, died by his own hand, being threatened with a judicial enquiry into the case of a patient who had died almost at once after he had operated on her for the

removal of both apices for tubercular phthisis. Of two similar operations by Krönlein, of Zurich (1884) one ended fatally in a few hours, the other in a few days. Of two by Ruggi[1] (1885), one patient, a feeble, delicate young man with disease of the left apex, died on the ninth day from carbolic acid poisoning; in the other, a man, aged 30, with disease of the right apex, it was found impossible to detach the lung from the pleura; he died thirty-six hours after the operation.

It is true that at least two operations have been successful. In 1893, Mr. D. Lowson[2] operated on a woman, aged 34, for tubercular disease of the right apex. He made an angular incision, beginning at the sternum, along the second rib, and resected the second and third ribs; then punctured the pleura, and slowly passed sterilized air into it, to induce collapse of the lung. This procedure caused no dyspnœa, no cyanosis. He then opened the pleura, freed some adhesions, and brought the apex of the lung out at the wound, transfixed it, and put a ligature round it, resected the diseased portion, and replaced the lung: no subsequent drainage. The part removed was half the size of one's fist, and contained a tuberculous mass surrounded by granulations. A fortnight after, there was an accumulation of blood, and later a purulent discharge. She left the Hospital eighty

[1] He lays down the following rules:—The opening into the chest must be in front, and must take the whole space occupied by the second, third, and fourth ribs from the sternum to the axillary line. The clavicle must always be avoided; the first rib must, as a rule, also be avoided. The skin incision may be either H or U-shaped. The resection should be made with the cautery, not the knife; and previous ligature or compression should be made of the portion to be removed. Drainage must be used. It is best not to suture the flap all round, for fear of emphysema. But see Tuffier's operation.

[2] "British Med. Journal," i. 1152, 1893.

days after the operation, with only a very slight discharge, having gained rapidly in flesh and in appetite.[1]

In 1891, M. Tuffier operated on a young man, aged 19, for tubercular disease of the right apex. He made an incision through the second space down to the pleura without opening it, and without resection of rib; he then carefully loosed the pleura off the ribs, as far as he possibly could, still without opening it, thus making a sort of pneumothorax outside it. Having felt, through the pleura, an induration in the lung, he now opened the pleura, grasped the lung with a forceps designed for this purpose, drew it forward through the slit in the pleura, and removed a portion of it containing a large tubercular mass; he used no subsequent drainage. 12 days later he showed the patient, healed, at the Société de Chirurgie. 4 years later (Oct. 22, 1895) he says: 'My patient continues to enjoy perfect health; the breath-sounds are absolutely normal at both apices.'[2]

[1] Mr. Lowson has very kindly sent me a note on this case. The patient left home to pay a visit; she was able to walk out, the breath sounds were normal, the chest was everywhere clear on percussion, temperature normal, marked falling-in of chest-wall where the ribs had been resected. She came home with signs of acute gastric ulcer (coffee-grounds vomit, hæmorrhage from bowels), and died about 9 months after the operation. It was impossible to get leave for a *post mortem* examination. We must all regret that the success of this most skilful operation was so suddenly brought to an end.

[2] 'Surgical interference is easy enough, and free from danger, in these cases, if the surgeon will carefully follow the rules that I have laid down. The real risk is that of pneumothorax; but you can make sure of avoiding it, if before you open the pleura and suture its two layers together, you take care to loose it off the ribs all round as far as you can reach. In this way you establish a sort of pneumothorax between the chest-wall and the pleura, and this keeps the two layers of the pleura in close apposition, so that when you do open the pleura air does not enter the pleural cavity. It may be quite true to say that tubercular phthisis, in a general way, is past the help of surgery; nevertheless, there are certain cases where the disease is circumscribed, in which the surgeon may get very good results. I know such cases are rare—they are the exception, not the rule—but still they do occur.' The nodule was the size of a large hazel-nut.

To read this operation, which was the outcome of many dissections made by M. Tuffier, when he was a prosector, for ascertaining the right way of reaching the apex of the lung, and to realize that he cured his patient by a simple incision, without resection, which healed without drainage in a few days, is almost enough to make one believe that here is a new field of surgery. But the old objection still holds good, that the disease in its early stage has not come to resection, and in its later stages has passed beyond the hope of benefit from it.

5.—Incision of a Tubercular Cavity.

Last among the surgical measures possible for the relief of phthisis, I have put the one which, within certain limits, has done most good. Of course it aims only at alleviation, not at cure; but it can perform what it promises, and when we know that there are cases where the lung, before death, is simply one huge fœtid thin-walled abscess, we are bound to make the most of the only efficient method for their relief.

The records of this operation are not very numerous, but the advantages that may be gained from it are beyond dispute. The earliest case is that of one Pheræus, who, having a cavity in his lung, and weary of life, put himself in the forefront of the battle, and received a spear-thrust which opened his cavity, and restored his health. And, to obviate the natural difficulty of believing this, there is De Bligny's case (1679): 'The son of M. de la Genevraye, a gentleman of high estate, was the subject of phthisis, and all hope of his recovery had been abandoned. In 1670, he received a wound from a sword in his chest; the weapon entered near his right breast, between the fourth and fifth ribs, and passed into a cavity in his lung. There was an abundant

purulent evacuation from the wound. After this accident, he completely recovered of his disease.'

I give, to begin with, a set of cases to show the indications for this operation, and the good that the surgeon may hope will come of it.

1.[1] A young man, aged 19, of a tubercular family, after many months of treatment for 'pneumonia' of the right lung, was admitted to Hospital for supposed empyema of right side; but careful examination showed signs rather of a huge cavity in the lung. *Operation*, incision over sixth rib, a little behind axillary line; rib trephined,[2] not resected; trochar and cannula thrust into cavity, and 12 ounces of curdy pus let out, which was loaded with the bacilli of tubercle; drainage, and daily irrigation. Marked rapid improvement: the temperature fell to normal, the cough and expectoration ceased, and the patient began to put on flesh. Three weeks later he broke down with acute disease of the opposite lung, and died a month after the operation. *Post mortem*, the right lung, adherent over its whole extent, was one huge thin-walled abscess-cavity, communicating with the anterior mediastinum; so that this was full of pus, and the back of the sternum was carious. The opposite lung was everywhere invaded with tubercles, those toward its centre being most advanced, as though this lung had become infected from the other.

2. A man, aged 38, was admitted to Hospital in January, 1884, with advanced phthisis. There was diffuse swelling below the left clavicle, and finally a large abscess formed here, the size of one's fist, extending from the clavicle to the fourth rib; he suffered fever, diarrhœa, profuse sweats, and severe pain. The abscess was incised, and a large quantity of very fœtid sero-purulent fluid, with air and sloughs, was let out; careful scraping of its walls exposed a channel running inward through the second space; irrigation caused great distress of breathing. The abscess was drained; the temperature, which had been over 104° before operation, never rose above 101·3°, the discharge became less abundant and less fœtid. He died fifteen days after the operation.

---

[1] Surgeon-Captain Moffet, "Brit. Med. Journ.," March 7th, 1896. For other references, see Truc.

[2] Rey has lately revived this ancient method. See "Brit. Med. Journ." Epitome, Sept. 21st, 1895.

Post mortem examination showed extensive tubercular disease of both lungs; very thick pleural adhesions at the wound, and a channel running through a thin layer of lung-tissue into an enormous cavity in the lung.

3. A man, aged 31, was admitted to Hospital with advanced phthisis; expectoration purulent and fœtid, hectic fever, signs of a large cavity in the right apex. This was punctured with a trochar and cannula, but only a few drops of pus escaped, with some air. The cavity was washed out through the cannula, and later the opening was enlarged; the fœtor disappeared, and the cough and expectoration were diminished, but his general condition remained very bad. He died a month after the operation.

4. A man, with advanced phthisis, was admitted to Hospital with a large cavity in the left lung. It was incised, drained, and sprayed through the drainage-tube; it became so nearly healed that the tube had to be first shortened and then left out, and neither pus nor air came from the wound; the physical signs improved, the tenderness on percussion disappeared, the lung contracted; and ten weeks after the operation he had so far gained strength and weight that he left the Hospital and went back to work. Eight months later, he returned with fresh extension of the disease, both lungs being now affected, and died a year and a quarter after the operation. *Post mortem* examination showed wide-spread tuberculosis and amyloid disease.

5.[1] A man, aged 38, with a history of hæmoptysis in 1841 and 1843, was in 1844 suffering painful cough with profuse purulent blood-stained expectoration, and showed signs of a cavity below the left clavicle, with some dulness and bronchial breathing over the opposite lung. An incision was made over the cavity, and it was punctured with a trochar and cannula; only air escaped, and there was a little bleeding from the wound and from the mouth. A tube was inserted, but did not fit, and was taken out, the wound being simply covered with a water dressing; two days later, a piece of catheter was inserted. His cough and expectoration almost disappeared, and pus flowed from the cavity on the ninth day after operation. Three weeks later, the cavity was nearly closed, and his general health and strength were greatly improved.

I believe that these five cases show fairly the measure

[1] This is the famous Hastings-Storks case.

of good that the surgeon may hope to do by incision and drainage of a tubercular cavity. He may, of course, meet with difficulties: in one case, a circumscribed pneumothorax in a phthisical patient was incised in the belief that it was a cavity in the lung; in another, the surgeon made his incision too low, indeed between the eleventh and twelfth ribs, and failed to drain a huge cavity; in another, there was troublesome hæmorrhage from the cavity after operation; in more than one, the use of irrigation gave considerable distress. Nor can he ever expect to cure his patient; and out of 13 cases collected by Truc, 6 died within three months of the operation.[1] Still, in some cases, he may give great relief for a time, and may be able to ensure that his patient shall at least be saved from acute distress during the short span of life that is all he can hope to have. And we must note that Sonnenburg (1891) got very good results, in two cases, from the use of Koch's fluid after the operation. He speaks very emphatically of the value of this method, observing that we can thus, when the cavity has been opened and drained, bring about a healthy change in its walls without risk to the patient.

The four following cases[2] illustrate three of the troubles that I have just mentioned: mistake of the pneumothorax for the tubercular cavity, hæmorrhage after the operation, and failure to find the cavity.

1. A man, aged 29, in advanced phthisis, with violent cough, purulent expectoration, fever, and emaciation, presented signs of a large superficial cavity in the upper part of the left lung (fulness over first and second spaces, bronchial breathing and cracked-pot sound below left clavicle, dulness

[1] Poisier and Jonnesco ("Gaz. des Hôp.," 1891) collected 29 cases: 10 deaths, 15 improvements, 4 'recoveries.'

[2] Bull, 1883; Delorme, 1889; Michaux, 1890 and 1893.

above both clavicles, moist *râles* both sides, most marked over left apex) and the diagnosis was made that he had a superficial cavity, with pleural adhesions. Exploratory puncture only drew blood and caused the sputa to be blood-stained. An incision was made, and an empty, circumscribed cavity was exposed; at the bottom of it lay lung tissue, as was proved by puncture with a director. Nothing more was done. Next day some pus flowed from the wound, four days later it became fœtid, and next day the patient died. *Post mortem*, the incision had opened a circumscribed pneumothorax; the lung was retracted two inches from the chest-wall; there was a large cavity in it, about an inch above the level of the operation-wound, unopened.

2. A young man, with pyo-pneumothorax, was treated with incision (1889) in the usual way; irrigation was attempted at the time of the operation, but caused convulsive cough and some hæmoptysis. Two hours later, he had a sudden profuse hæmoptysis, and the dressings and the bed were soaked with blood. 'What was I to do? It was no good trying compression, or occlusion of the wound, or fixation of the chest with a bandage. I removed the dressing, and found blood flowing in jets through the drainage-tubes. First, I plugged the wound, but without hoping to do much good in this way; then, as the patient was still getting weaker, I took out the plug, opened up the wound, injected iced water into the pleura, slipped pieces of ice into the chest, put ice outside it, and compressed the main arteries of the limbs. As this was not enough, and he was terribly blanched, I had recourse to digitalin and to ergotin, keeping on with the ice. The bleeding stopped at last, more from syncope than from treatment; but the fear of bringing it on again made the work of restoring him very anxious, and I did not leave his side for seven hours.'

3. A woman, aged 26, was admitted to Hospital, having taken poison to be rid of her sufferings: these had begun six years ago, with pleurisy, and for four years she had suffered profuse purulent expectoration, sometimes fœtid. In spite of repeated careful examinations, exact diagnosis was impossible; it lay between a cavity due to bronchiectasis, with chronic pneumonia, and an empyema toward the diaphragm with an opening into the lung; and she remained for over a year in Hospital before operation. Then an incision was made, and four inches each of the seventh and eighth ribs were resected; the pleura was opened, and it was noted that the lung was slightly œdematous, congested, and firm, but no

defined induration was felt. A fine aspirating needle was passed in eight or ten different directions into the lower lobe of the lung without finding either the slightest trace of a cavity or the very smallest patch of indurated tissue. Finally, with Paquelin's cautery, an incision was made through the lung, three or four inches long, and at least two inches deep; some dilated bronchi were thus opened up, but no pus and no cavity were anywhere to be found; the wound was left open, and packed with iodoform gauze. No marked improvement followed, and she died about a month later. *Post mortem*, there was found a very small cavity, deep in the lung, not far from the track of the cautery, in the thickness of the inner part of the lower lobe, with tubercular phthisis.

4. A woman, aged 28, was admitted to Hospital for operation, having either a small tubercular cavity or a bronchial dilatation at the base of one lung. As the physical signs were not sharply defined, operation was put off, and she left the Hospital, but returned in a few days. The probable site of the cavity was now very carefully mapped out on the chest-wall, an H-shaped incision was made below the angle of the scapula, and about two inches each of the eighth and ninth ribs were resected. With a Paquelin's cautery, an incision was made in the lung, about two inches long, and about two inches deep; but no cavity was anywhere found. She died about three months later, with signs of bronchiectasis and tubercular phthisis. *Post mortem*, the tubercular changes were most marked.

We have now reviewed the five methods of surgery which have at present been found possible for the treatment of tubercular phthisis; and we have found that the two sets of cases where the surgeon may do most good are those of fœtid pyo-pneumothorax, and those of large tubercular cavity with septic absorption. It is the general condition of the patient that gives the key to the question of interference or non-interference; and such relief may be given by incision and drainage that the operation may most truly be successful, even though the disease goes on to its natural end.

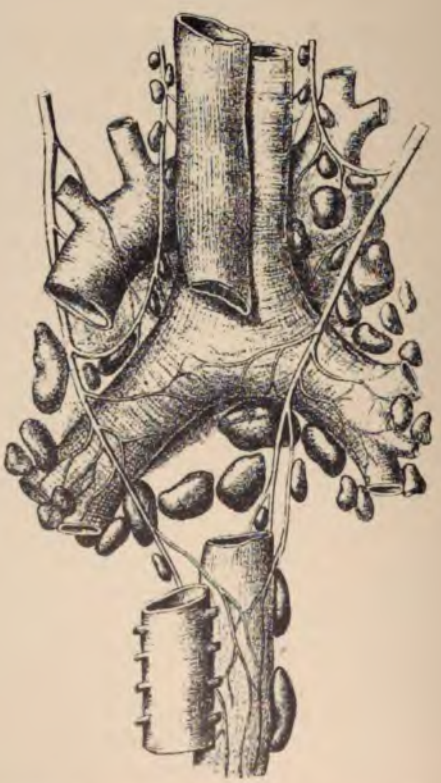
CHAPTER XXII.

SOME DISEASES OF THE BRONCHIAL GLANDS AND POSTERIOR MEDIASTINUM.

We have now come to a group of diseases that oppose to the physician and to the surgeon almost insuperable difficulties. The various forms of inflammation of the bronchial and mediastinal glands, though they frequently end in death, are often unrecognized during life. They tax to the utmost the physician's powers of diagnosis, and are almost out of the surgeon's reach. Not that it is impossible, by a carefully planned operation, to gain access to the posterior mediastinum; but, by the time the indications for such interference are clearly marked, the harm has already been done: and, at present, in spite of the anatomical work of Quénu and Hartmann, Nosiloff, and Joseph Bryant, we can hardly speak of the surgery of the posterior mediastinum. Still, there is no anatomical reason against it; and, apart from the possibility that we may come to operate directly and of set purpose on this region of the body, the diseases of these glands, and of the mediastinal space that contains them, may in this or that case stand in need of surgery: we are therefore bound to make careful study of them. It is only of late years that much has been written about them: what I put here is mostly taken from the work of Neveux, Beez, Seitz, Kolisko, and Voelcker.

The bronchial and mediastinal glands are so numerous, and set so close together, that it seems hardly reasonable

PLATE X.



The Bronchial and Mediastinal Glands, seen from behind. (From Guéneau de Mussy, Clinique Médicale, vol. iv.)

to describe separate groups of them, but they are chiefly to be noted: (1) in front of the bifurcation of the trachea, and in close connection with the main bronchi; (2) beneath the bifurcation and the main bronchi; (3) in the angles of the chief branches of the bronchi; (4) round the œsophagus. The illustration (*Plate* X.) shows clearly that they are only too likely either to catch infection or spread it, and are indeed dangerous neighbours, easily provoked and hard to withstand.

Setting aside malignant disease,[1] there are three infective diseases of these glands we have to consider. First, acute septic inflammation with sloughing; next, chronic inflammation, with pigmentation and fibrous and calcareous degeneration; last, tuberculous disease. It is, of course, possible for a mixed infection to occur: still, these three forms are so far distinct that we must, for practical purposes, consider them separately.

Acute Septic or Gangrenous Inflammation.

We owe to Neveux[2] our gratitude for an admirable account of this disease. He has described it so clearly and fully, that we come in danger of forgetting that its diagnosis is full of difficulty, and that there is at present no record of an operation practised directly for its relief. The following abstract of his work may at least serve to show its great value:—

'During the last twenty years,' he says, 'we have begun to study the diseases, acute and chronic, of these glands; we look for them in every *post mortem* examination; we diagnose some of them at the bedside. It is certain that

[1] For *primary* malignant disease of these glands, see a paper by Dr. Newton Pitt, "Path. Soc. Trans.," 1888, p. 54.

[2] Georges Neveux "De la Gangrène du Médiastin, et de la Gangrène Pulmonaire Consécutive," Paris, 1895.

one day we shall diagnose them all: and we must hope that surgery, always making fresh claims and always justifying them, will in time find a way into the posterior mediastinum, and reach the sloughing glands in it, just as the surgeons of the present day open a gangrenous cavity in the lung.' Gangrene of the mediastinum has at present been overlooked, or confounded with gangrene of the lung, which is a common result of it, and *vice versâ* may be the cause of it. But in nine cases out of ten the cause is ulceration and perforation of the œsophagus.

Baréty was one of the first to call attention to it. He put together four cases of gangrenous inflammation of the glands, one from gangrene of the larynx, one from septic endocarditis, one from gangrene of the lung, and one where the glands themselves seemed to be primarily attacked. Gangrene of the mediastinum, then, is not always due to perforation of the œsophagus: and again, it may come from extension of inflammation downward from the neck (cellulitis, retro-pharyngeal abscess) or from extension of disease from the lung. Again, the perforation of the œsophagus, which is the one great cause of the disease, may of itself be due to degeneration (tuberculous, calcareous, or syphilitic) of the very glands which now in their turn become infected from the œsophagus. Still, the rule holds good that gangrene of the mediastinum is due, in almost every case, to putrid infection of the mediastinal glands from ulceration of the œsophagus. The causes of this ulceration are of all sorts and kinds: laceration by foreign bodies, by sword-swallowing, by rough use of a bougie, burns with corrosive fluids, stricture, malignant disease, and various forms of inflammation in or immediately around the œsophagus.

The abscess-cavity caused by the sloughing of the

glands thus infected is usually situated at the bifurcation of the trachea, behind and below the right bronchus: in front of it is the pericardium; behind it, the adherent pleura; above, the right bronchus and the root of the lung; to its right side, the right lung; to its left, the œsophagus, the right pneumogastric nerve, and the arch of the aorta. It is rarely more than an inch or so in diameter, in one case only it measured 2½ inches. Its walls are soft, dark, smooth, and regular, not sinuous like the walls of a gangrenous cavity in the lung; its contents are greyish, fœtid, and may contain the remnants of a gland, or what remains of the gland may be found still adherent to the walls of the cavity.

Perforation may occur in many ways. There may be purulent or gangrenous pleurisy, or fœtid pyo-pneumothorax, from a large irregular ragged perforation into the pleura, far back, near the posterior border of the lung. There may be putrid bronchitis, or broncho-pneumonia, from a perforation of the right bronchus, or of the left, or of both—small, clean-cut openings, as if they had been punched out. The lung may be perforated, and become the seat of gangrene, diffuse rather than circumscribed: or the fœtid pleural effusion due to perforation of the pleura, may set up a superficial gangrene of the lung. The great vessels may give way, though this very rarely happens; or the œsophagus itself, the cause of the disease, may in its turn be perforated by it.

The organisms that bring about these evil results are the same that are found in gangrene of the lung, and in putrid empyema; not only the streptococci and staphylococci, but higher forms of life, spirilla and amœbæ.[1]

The symptoms of mediastinal gangrene are so nearly

[1] It has been shown that the injection of saliva into the lungs of a rabbit is invariably followed by pulmonary gangrene.

those of gangrene of the lung, that an exact diagnosis is almost impossible. But a clear history of some previous injury or disease of the œsophagus may help toward it, and the patient may complain, early in the disease, of sharp pain behind the sternum, or down along the spine. Except for these vague indications, the other signs of the attack—a general feeling of illness, distaste for food, cough, fever, shiverings—give no definite information; but it is to be noted that the breath may be fœtid very early in the disease. Later, the signs are those of the extension of the gangrenous process, by infiltration or perforation, beyond its original site—the case becomes one of diffuse or (more rarely) circumscribed gangrene of the lung, or putrid empyema, or pyo-pneumothorax, and is treated as such, without success.

This abstract of Neveux's account of mediastinal gangrene must not make us forget that it can hardly, during life, be distinguished from gangrene of the lung, and that up to the present time there is no record of any direct operation on it. It belongs at present to pathology rather than to clinical medicine or surgery. 'We must hope,' he says, 'that more cases will be published, that it will take its place among recognized diseases, and that we shall finally be able to diagnose it. When this has been done, the surgeon who operates on the gangrene of the lung that is the result of it, will also operate on the disease at its starting-point, and from this rational treatment we may expect definite good results.'

Chronic Inflammation and Degeneration.

The bronchial and mediastinal glands of all those who live in cities, or work at dusty trades—stone-masons, felt-workers, pitmen — tend to become pigmented, shrunken, tough, and degenerate; fibrous toward their

surfaces, broken-down or calcareous toward their centres. These changes come so slowly that they belong essentially to adult or late life, and have only once or twice been noted in children. They seldom do harm, but in a few cases the gradual shrinking of the glands and their adhesions has caused narrowing or kinking of the œsophagus, the air-passages, or the great vessels; or even perforation has occurred: or, after lying harmless for years, the glands may become the seat of some fresh infection leading to acute or gangrenous suppuration.

To illustrate compression and perforation of the air-passages, we may take the account of two specimens given by Tiedemann.[1]

1. 'The whole trachea, at its bifurcation, is so narrowed that the passage is reduced to a mere slit. It is surrounded here by a thick, fibrous growth, an inch thick in some places, which has pushed the cartilaginous rings inward; this is composed of very dense, fasciculated fibrous tissue—part greyish-white, part pigmented—enclosing shrunken, broken-down, crumbly glands. The right bronchus is also constricted by the growth.'

2. 'In the left bronchus, the third and fourth rings touch, and project inward into the bronchus, and between them is a pin-head opening leading into a minute diverticulum. The fifth ring is broken, and the mucous membrane over it is sunken. Round the bronchus is a quantity of whitish fasciculated scar-tissue, containing, just at the point where the bronchus is diseased, the remains of a shrunken, pigmented, calcareous gland.'

Or the glands and the tissue round them may, as they shrink, drag on the œsophagus and cause pouching of its wall. These 'traction-diverticula' of the œsophagus have been studied by Zenker, who collected 60 instances.

---

[1] For this and other references, and a good account of the whole subject, see Beez, "Ueber Seltenere Vorkommnisse bei Necrose und Vereiterung von Bronchial-drüsen," Inaug. Diss., Jena, 1895. Also a paper by Dr. Rolleston, "Path. Soc. Trans." 1894, p. 23.

They occur, of course, about the level of the bifurcation of the trachea, and are usually directed upward : in most of them, the muscular fibres are frayed out, and the mucous membrane is wrinkled and pigmented. They are so small (being on an average the size of a pea) that their importance comes only from the danger of perforation.

Biedert gives a long list of the effects that may follow various diseases of the bronchial glands. He collected in all 420 cases : in 8, the aorta was compressed ; in 22, the pulmonary artery ; in 6, the vena cava superior ; in 1, both the pulmonary artery and the veins ; and in 1, the vena azygos. The trachea and the bronchi were compressed in 77, perforated in 57, and were the seat of diverticula in 4. The œsophagus was compressed in 8, perforated in 18, and was the seat of diverticula in 50. The most likely sites for perforation of the trachea or bronchi are the angles of bifurcation, these being naturally beset with glands. Pressure may also fall on the pneumogastric and recurrent laryngeal nerves, very rarely on the phrenic.

The following two cases[1] are good examples of this chronic degeneration of the glands in adult life, ending in a fatal re-infection. It will be noted that these old, shrunken, or calcified glands may have been in early life tuberculous.

1. A woman, aged 64, was admitted to Hospital already dying : all that could be learned of her was that she was in her usual health up to ten weeks ago, when she began to cough, and frequently complained of cutting pains in the chest. *Post mortem* examination showed general parenchy-

[1] Kolisko, "Alter Abscess der Bronchialdrüsen, durch Perforation zur Mediastinalen Phlegmone führend," "Wien. Klin. Wchnschr.," 1891, p. 665. Tice, "Med. Chir. Soc. Trans.," 1843, p. 19.

matous degeneration of the viscera, and acute swelling of the spleen, pointing to some acute recent infection. All the loose cellular tissue of the posterior mediastinum was infiltrated with sero-purulent fluid, especially above the bifurcation of the trachea. Lower down, between the main bronchi, was a large, thick-walled abscess cavity, containing similar fluid: it pushed the bronchi outward and partly occluded them, and pushed the œsophagus backward and to the left; and it opened, below the right bronchus, into the posterior mediastinum. In its wall lay a small pigmented, degenerate, partly-calcified lymph-gland, which also had perforated the right bronchus: and this bronchus was ulcerated higher up over another similar gland. The whole process had evidently taken a long time: the glands may have been originally tuberculous: the abscess-cavity had been there probably for many years, and then some fresh infection had made it enlarge and break into the posterior mediastinum. The perforation of the bronchus, from its thin and scarred edges, was of long standing.

2. A man, aged 48, began about September 7th, 1842, to complain of pain in the right side, slight embarrassment of breathing, and a very foul taste in his mouth of a morning, and pressure over the liver gave him pain: he was treated with purgatives and venesection, and got worse. A few days later, he began to have paroxysms of coughing, and was easiest when he was leaning forward with his hands on his knees. He was distressed at the fœtor of his own breath, but this was not perceptible to others. He still referred his pain to the liver, and had sharp pain when it was pressed upward against the diaphragm. He got steadily worse, and many kinds of diagnosis and of treatment were given and then abandoned. He now stated that he had felt pain in his chest while eating a pear three weeks before his illness, and thought some of it must have stuck on the way down; and he pointed to a place a little below the left clavicle, where everything that he swallowed still seemed to stick. In October he was worse in every way, with profuse fœtid expectoration, and attacks of faintness and of choking. The lungs became congested, and he died comatose on October 18th, after six weeks' illness. The *post mortem* examination showed a fœtid abscess-cavity in a mass of glands at the bifurcation of the trachea, opening wide into both bronchi, and into the œsophagus. It contained a quantity of calcareous matter, and a hard calcareous mass was wedged in the opening into the right bronchus.

The second of these two cases is, I believe, the earliest record of this form of mediastinal abscess; and Dr. Tice's account of it gives a most admirable picture of the disease.

Tuberculous Abscess of Children.

We come now to a set of cases that are somewhat more definite in character, and have been of late years very carefully studied. The work of Voelcker, Pitts, Seitz,[1] and many others, has given us a clear picture of the disease: and early recognition of it may help us to check its progress. The fact that it may be excited by any long-continued irritation of the glands must make us careful to treat cases of simple chronic cough in children.

These cases of tuberculous bronchial and mediastinal glands in childhood seem to divide themselves into two chief groups, which we may practically call early and late, or medical and surgical, or before perforation and after it. This division, though it looks absurd, is justified by the changes which follow perforation, calling in most cases for such relief as an operation may be able to give. To illustrate the diagnosis of the disease in its earlier stages, I give a case from Dr. Voelcker's work on this subject, and an abstract of Seitz's paper and of the discussion that followed it: but Seitz's list of signs and symptoms is derived from other diseases of these glands as well as from that which we are now considering, and seems to

[1] Voelcker, "On some Effects produced by Caseous Bronchial Glands in Children," "Practitioner," June, 1895; Pitts, "Surgery of the Air-passages and Thorax in Children," "Lancet," Oct. 1893; Seitz, "Die Klinische Diagnose der Bronchialdrüsen-erkrankungen," "Wien. Klin. Wchnschr.," 1894, p. 968. The cases here quoted are taken from Voelcker and Pitts. See also Gee, "St. Bart. Hospl. Reports," 1877, p. 63: and Gulliver, "Path. Soc. Trans.," 1889, p. 38.

include not only what we do find in these cases, but also all that we might find.

A little boy, 6 years old, was admitted to Hospital with cough, shortness of breath, night-sweats, wasting, and vomiting; no hæmoptysis. (It was said that he had swallowed a small lead weight, about three months before admission, and had never since then seemed well.) There was deficient movement of the right side of the chest; the breath-sounds were weaker over the right side than over the left; a few moist râles were heard, during inspiration, on the right side only. Two days later, there was faint but distinct tubular breathing over the right interscapular space, at the level of the spine of the scapula, and the voice-sounds here had a nasal tone. Five days later, the breath-sounds were markedly weaker over the right upper lobe than over the left, and vocal fremitus and vocal resonance were more marked in the right interscapular region than in the left. From this time onward, the signs were those of rapid phthisis of both lungs; but repeated examinations failed to find the tubercle-bacillus. He died six weeks after admission: the *post mortem* examination showed a large mass of caseous glands at the bifurcation of the trachea, measuring $1\frac{1}{2}$ by 2 inches, flattening the right bronchus: advanced tubercular disease of both lungs.

Seitz, in an elaborate paper on the diagnosis of diseases of the bronchial glands, takes first their effects on the structures in their neighbourhood, and then the physical signs that they may present. Under the first division (functional disturbances) he puts the following changes:—

1. Compression of trachea or bronchi, leading to inspiratory dyspnœa, which is intermittent, and becomes worse when the patient sits up: very suggestive if it be more marked on one side than on the other; later, there may be signs of bronchiectasis.

2. Dilatation of the veins of the face, neck, front of chest, and upper limb. Œdema, cyanosis, epistaxis, meningeal hæmorrhage, hæmoptysis: increased action, or even hypertrophy, of the heart; a venous murmur at

the upper part of the sternum, due to compression o the vena azygos.

3. Attacks of cough, of a character like that o whooping cough; spasmodic asthma; hoarseness or los of voice from pressure on the recurrent laryngeal nerve.

4. Difficulty of swallowing, from traction on th œsophagus.

Under the second division (physical signs) he in cludes: —

1. The presence of enlarged glands deep in th neck.

2. Percussion may show a small irregular area o dulness in the sternal or the interscapular region; bu this may be due in children to enlargement of th thymus gland.

3. Auscultation may detect a loud blowing sound in expiration, heard over the sternum, or over the third to fifth dorsal vertebræ.

4. Signs of perforation into the œsophagus or the trachea.

This number of signs and symptoms may be present in the last stages of malignant disease, but one will look in vain for most of them in the cases that we are now considering. The discussion that followed Seitz's paper is to be noted. Pott, of Halle, laid stress on the difficulty of distinguishing between enlarged glands and enlarged thymus. Fischl (Prag) said that the diagnosis of tuberculous disease is greatly strengthened if there be enlargement of the glands on both sides of the neck, just in front of the trapezius. He had often observed *post mortem* the connection between these two sets of glands; or one might remove one of the cervical glands, and examine it for tubercle-bacilli. Heubner (Berlin) said that tuberculous glands in children are in most cases

equivalent to incipient phthisis in adult life; the disease in children begins in the glands rather than in the lungs. He advised that the diagnosis should be settled by the use of Koch's fluid. Eisenschitz (Vienna) drew attention to the close connection between disease of these glands and whooping-cough. Enlargement of the glands may give rise to symptoms like those of whooping-cough, and a long attack of whooping-cough may cause enlargement of the glands, but this is not necessarily tuberculous, and the glands may go down when the cough stops. Kassowitz (Vienna) said that in children under 2 years old, rarely in older children, a condition may occur which is often mistaken for enlargement of the bronchial glands: a loud protracted in-and-out respiratory sound, without dyspnœa, often audible at some distance, and entirely disappearing during sleep.[1] All the children show the skull-changes of rickets. Probably it is a reflex disturbance, a spasm of the bronchial tubes, depending like laryngismus stridulus, and other allied states, on the rickety changes at the base of the skull. Wiederhofer (Vienna) said that one of the most important signs is an abnormally loud expiratory sound, heard more clearly over the left bronchus than over the right; and that one may sometimes find an area of dulness even in the earlier stages of the disease.

These opinions show the great difficulty of diagnosing tuberculous disease of the bronchial and mediastinal glands in children, at the time when there is still some hope that it may be arrested by putting the child in the best possible conditions for recovery. But when per-

[1] Dr. Gee (St. Bart. Hospl. Reports, 1884, p. 14) has described a somewhat similar sound, under the title "Respiratory Croaking of Babies." In a case of this kind, Dr. Lees found the epiglottis folded inward, so that its sides almost touched ("Path. Soc. Trans.," 1883).

formation has been set up, the character of the case is changed, and it is likely to come in need of surgical treatment.

The results of the disease from this point of view, are uncertain and very disappointing. In several cases, death has occurred almost at once: the child has been in ill health, with only a cough and a little freezing and fever, for weeks, and then has suddenly become suffocated, and died in a few hours or minutes. In others, time has been given for tracheotomy, which yet has failed to save life. In others, the disease, after perforation, has involved the posterior mediastinum and the lungs, giving rise to the phenomena of empyema; or has infected the lungs with tuberculous phthisis. In one, a boy 11 years [illegible] the gland was coughed up through the mouth, and the child recovered. These tuberculous glands of [illegible] may break into the œsophagus or great vessels.[1] From the point of view of surgery, the cases divide themselves into those where tracheotomy has been performed, and those where the chest-wall has been opened.

Tracheotomy, of course, is not likely to save the child. The three following cases are of special interest:—

1. A child, three years old, had for some weeks been subject to sudden attacks of dyspnœa, lasting from two or three minutes to half an hour, with cold sweats, duskiness, and coughing. There was some dulness over the upper part of the sternum, and signs of general catarrhal bronchitis. During a severe attack, tracheotomy was performed. Two days later, during a severe fit of coughing, two or three

---

[1] Webster, out of the records of 2,500 general *post mortem* examinations at the Great Ormond Street Hospital, found only 4 instances of perforation of the œsophagus; he gives also one of perforation of the pericardium; and Dr. Percy Kidd gives one of perforation of a branch of the pulmonary artery.

[2] Demme, Beez, Wright of Huddersfield.

spoonfuls of thick greenish caseous pus came through the cannula : it was found to contain tubercle-bacilli. The child was greatly relieved, and began to put on flesh ; but the cough continued, and seven weeks after the operation there were fine moist crepitations in the lower lobe of the right lung, purulent sputa containing tubercle-bacilli, finally tuberculous ulceration of the tonsils, œdema of the lungs, and death about half a year after the tracheotomy. The *post mortem* examination showed a mass of caseous glands below the trachea, with perforation of the trachea, and of both bronchi, and general wide-spread tuberculosis through the whole body: the submaxillary glands also were caseous.

2. A child, 5 years old, was admitted to Hospital, with acute dyspnœa and stridor : she had been subject to similar attacks for the last year and a half. Respiration 20, with marked dyspnœa, loud stridor, and violent inspiratory effort ; pulse 120, temp. 102·2° ; no dulness anywhere on percussion, coarse crepitations heard behind ; one enlarged cervical gland, and a soft swelling just above the sternum,[1] rising in expiration, disappearing in inspiration, giving no emphysematous crackling. Tracheotomy was done a few hours after admission. As soon as the deep fascia was opened, it was found that the swelling in the neck was due to emphysema: air bubbled up with each expiration, and could clearly be heard whistling in and out of the air-passages. The trachea was now opened, and a stream of thin pus ran out of it ; the source of it could not be made out ; no tubercle-bacilli were found in it. On the third day after the operation, the child came out in a scarlatinal rash, and later had desquamation, œdema, and hæmorrhagic nephritis. The cervical and submaxillary glands also became enlarged ; the emphysema remained for some weeks ; she finally made a complete recovery.

3. In a similar case, tracheotomy was performed on account of the urgent dyspnœa ; and as no relief followed the opening of the trachea, a catheter was passed down to its

---

[1] Similar emphysema occurred in one of the cases quoted by Voelcker, a child 4 years old, who had gone through a severe attack of measles a month previously. She suffered dyspnœa, and a swelling suddenly appeared in the neck, and spread up to the face and down over the trunk. With the onset of the emphysema, her breathing was relieved, and she coughed up some pus mixed with blood. The emphysema and purulent expectoration lasted about three weeks, and she then recovered.

bifurcation; this caused the child to cough up about an eggcupful of fœtid pus. Recovery.

The presence of emphysema, of a dull area, and of enlarged glands in the neck, is to be noted in these cases; and they also show that the surgeon ought to explore the main bronchi at the time of the operation, and perhaps also to fasten the wound in the trachea to the skin. He must remember, also, that the gland may be impacted in the glottis. But of course the exploration of the bronchi will lead to nothing if the dyspnœa be due to simple compression without ulceration, or rather to simple compression *plus* muscular spasm of the bronchial tubes.[1]

Incision through the chest-wall may be illustrated by the two following cases:—

1. A little boy, about 4 years old, was admitted to Hospital, having been ailing for six weeks: cough during the latter part of this time, and vomiting during the last few days. There was some dulness over the left side of the chest, with loss of vocal vibration, and impaired vocal resonance; breath sounds weak above, absent below. Pus was found with the exploring needle, but next day resection of rib and incision of pleura failed to find pus or to open any cavity in the lung. A month later, the vomiting returned, and on one occasion he brought up blood; the signs

[1] It may be well to note here the possibility of treating certain cases of stricture of the trachea or bronchi by the use of bougies. Seifert (Ueber Tracheo-broncho-stenose und deren Abhandlung, "Wien. Klin. Wchnschr." 1894, p. 950), gives the case of a man, aged 43, with signs of stricture of the trachea in two places, and of the left bronchus. Having treated the tracheal strictures with bougies, he passed an English œsophageal bougie, 9 size, a distance of 17½ or 18 inches from the teeth. 'The patient declared with confidence (!) that the bougie had passed into the lower lobe of the left lung.' Some improvement followed.

We may also note that it is just possible for extreme dilatation of the left auricle to cause narrowing of the left bronchus. Two cases of this are recorded by Dr. H. H. Taylor and Dr. Lee Dickinson, "Path. Soc. Trans.," 1889 and 1893.

of disease in the lung became more marked, and he died suddenly, six weeks after admission, with hæmorrhage by the mouth and from the bowels. The *post mortem* examination showed the lung to be adherent and gangrenous at the seat of operation, with tuberculous consolidation of its upper lobe; a mass of caseous glands had perforated the left bronchus, and the anterior surface of the œsophagus was perforated in two places. There was recent dark blood-clot in the stomach and intestines, and there were caseous glands in the neck.

2. A child, aged 5 years and 9 months, was admitted to Hospital with signs of a cavity in the posterior part of the right lung; fever, hæmoptysis, and fœtor of breath. Resection was made of the sixth and seventh ribs in the right interscapular region; the lung was adherent, but repeated exploratory punctures failed to find any cavity in it. The child died a few hours after operation. The *post mortem* examination showed an abscess the size of a walnut, invading the root of the right lung, and opening into the right bronchus; there were caseous glands close to it, but no tuberculous disease elsewhere; several patches of gangrene in the lung.

We have now gone through the chief affections, excluding malignant disease, of these glands and of the posterior mediastinum. We have still to take note of the anatomical observations recently published as to the best method of exposing and opening the mediastinal space.

These observations have been made chiefly to find what hope we have of removing foreign bodies, by this method, from the œsophagus or the bronchi. The removal of such bodies from the bronchi by direct incision has been proved, as we shall see in the next chapter, to be almost impossible; it is one of the most dangerous operations ever devised. The removal of foreign bodies from the œsophagus belongs rather to general surgery; at all events, I do not know that the posterior mediastinum has yet been opened for any operation of this kind.

Three series of dissections[1] have been made lately o the surgical anatomy of this region; and I give at som length an account of two of them.

QUÉNU AND HARTMANN'S OBSERVATIONS, 1891.

'We thought at first that one ought to keep as close a possible to the spine, dividing the ribs close to th transverse processes of the vertebræ; but we soon foun this plan a bad one, because the bodies of the vertebra push the aorta and the œsophagus too far forward. It i infinitely better to make the incision well away from th spine, and, as nearly as possible, level with a line draw across the back wall of the mediastinum. The best wa is to divide the ribs at their angles.

'We therefore recommend the following operation:— A vertical incision, 6 inches long, over the angles of th ribs, about 4 fingers' breadth from the spine, with it centre level with the spine of the scapula, or, better stil with a point a little below it. By retracting the lowe edge of the trapezius upward and inward, one need onl divide a few fibres of this muscle. Next, one divides th rhomboideus, and gets to the outer side of the dee muscles of the spine; these may be left undisturbe The ribs are then cleaned and resected, about 2 inche of each. This amount of resection, of three ribs only allows you, after stripping up the pleura, to get you whole hand into the posterior mediastinum. It has bee suggested that one ought to turn back the divided piece

[1] Nosiloff, "Œsophagotomia et resectio œsophagi endoth racica," 1888; Quénu and Hartmann, "Des voies de pénétratio chirurgicale dans le médiastin postérieur," Soc. de Chir., Pari 1891; Joseph Bryant, "The surgical technique of entry to th posterior mediastinum," Trans. Amer. Surg. Ass., 1895, p. 44 A short account of Nosiloff's paper is given in the "Annals Surgery," 1889.

of ribs, instead of removing them, but this merely complicates the operation, and is not necessary. We need not say that all bleeding must be stopped, and the intercostal vessels must be ligatured.

'In this way, you make an opening into the chest, measuring, from the second rib to the upper border of the sixth, 4 to 5 inches in length; and if you draw the ribs outward, you can see and explore the root of the lung, the aorta, and all that part of the œsophagus that lies between the bronchi and the diaphragm. If you incise the pleura instead of stripping it off the ribs, you can reach the upper lobe of the lung, and even the highest point of the pleural cavity, much more easily than by the anterior resection lately recommended in Germany for opening apical cavities.

'We do not know what will be the practical applications of these observations: *a priori* they seem to us to justify interference in cases of injury of the bodies of the vertebræ, mediastinal abscess, and compression of the bronchi or the œsophagus by certain glandular swellings. But, above all, they will, we think, be useful for the treatment of certain affections of the œsophagus, especially for the removal of foreign bodies which cannot otherwise be removed. We know that there is no slight risk in pushing them into the stomach; out of 22 patients thus treated, 8 died. And we should prefer our operation to Richardson's, where you open the stomach, introduce your whole hand, and pass instruments up the œsophagus from below.'[1]

---

[1] Quénu and Hartmann draw attention to the fact that the right pleura passes slightly beyond the middle line, forming a *cul-de-sac* between the aorta and the œsophagus; the posterior mediastinum should therefore always be approached from the left side.

BRYANT'S OBSERVATIONS, 1895.

'The patient should be placed obliquely on the abdomen, with the shoulders so supported as to cause the least possible interference with the movements of the thorax, and with the arm hanging over the table so as to draw the scapula as far outward as possible. The centre of the field of operation should correspond to the seat of obstruction. The tip of a spinous process, in this part of the spinal column, is opposite to the rib of the next vertebra below; and therefore the tip of a spinous process will indicate the rib at the centre of the field of operation.

'A flap three inches square, including the tissues down to the ribs, and reflected inward, affords ample space. Portions of not less than three ribs must be displaced, from their angles to the outer extremities of the transverse processes. The middle one of the three must be carefully exposed with a raspatory; the pleura must be stripped off it by means of a silk thread passed with an aneurysm-needle between the rib and the pleura, and worked to and fro so as to loosen the pleura; the rib is then divided with a chain-saw, and removed, and its vessels ligatured. The pleura is then very carefully stripped from the rib above and the rib below: this must be done with the fingers only, and during expiration only; then these ribs are divided, and turned upward and downward, but not removed. The separation of the pleura from the ribs, bodies of the vertebræ, etc., must be conducted with great care; if a rent takes place, it must be closed at once. If the pleura be gently pushed outward, the movements of a bougie in the œsophagus can be clearly seen; a strong electric light is a very important aid. Below the arch of the aorta, the

œsophagus is reached better from the right side; above the arch, it can be reached from either side, but better from the left.'

Such are the two operations suggested, from anatomical observations, for opening the posterior mediastinum. It will be noted that they have been planned rather for the removal of foreign bodies than for the relief of suppuration. They do not agree well together, and it is certain that either of them would be attended by grave difficulties, and would often be followed by death. It is indeed rather bewildering to find this sentence in Mr. Bryant's essay—'Suffice it to say, that the venæ azygos, the aorta, and the pulmonary vessels, along with the pneumogastric nerves, *must be courteously approached and considerately treated.*' Most of us would wish to show our courtesy and consideration toward these structures in some other way than by approaching and treating them. Still, the operation is possible, and I think it would be justified for the saving of life in septic or gangrenous inflammation of the posterior mediastinum.

NOTE.—Cases of fatal mediastinal abscess from sword-swallowing, and from foreign body impacted in the œsophagus, are recorded by Dr. Charles Gross and Dr. Sharkey, in the "Transactions of the Pathological Society," for 1885. In the "Society's Transactions," for 1887, Dr. Lauriston Shaw has recorded a case of bronchiectatic cavity in the lung, from impaction of a tuberculous bronchial gland, in a child only two years old.

CHAPTER XXIII.

FOREIGN BODIES IN THE AIR-PASSAGES.

CLINICAL records of the signs, treatment, and results of foreign bodies in the air-passages are common in the literature of surgery; and the statistics of operation are, on the whole, very good. But in addition to all the manœuvres practised at the time of tracheotomy, or after it, we have to consider the advice given us of late years, that in certain desperate cases an attempt should be made to reach the foreign body either from the front of the chest, or through the substance of the lung, or by exposing the main bronchus from behind in the posterior mediastinum.

Reversing the natural order of things, let us first try to estimate the value of these proposed new methods, and then take a general view of the whole subject, and of the advantages gained by tracheotomy with exploration of the bronchi. Of course the new proposals apply only to cases where tracheotomy and all attempts to remove the foreign body through the trachea have failed, and there is active mischief in the lung.

1. Dr. Rushmore,[1] in a case of this kind, endeavoured to reach the bronchus through the front wall of the chest; he turned down a flap 3 inches square, cut through the pectoral muscle, drew it out of the way, and was about to make resection of the ribs when the patient's condition became so bad that the operation had to be abandoned.

[1] "New York Medical Journal," July, 1891.

His account of the case is full of interest: I have noted it further on. I have found no record of any other attempts to reach a foreign body by this method.

2. Truc suggests that in a desperate case an attempt should be made to reach it through the thickness of the lung. 'When all other methods, including tracheotomy, have failed—when the patient is in danger of death—when percussion and auscultation give unmistakable evidence of a foreign body in the lung-tissue—then have we not the right to go straight for it through the chest wall? If you know accurately where it is, you cannot hesitate what to answer—you must operate. I know that the localization of the foreign body is full of difficulties, but they do not seem to me necessarily insuperable. In some cases, inflammation of the lung—more or less severe, more or less extensive—may give us the guidance that we so sorely need: auscultation and percussion may tell us the position of the enemy; the patient himself may refer his pain to one particular place. Finally, exploratory punctures, made with a light hand and a good judgment, may, in some cases, justify operation. If you go carefully and use the cautery, the danger will not be excessive: and it is your patient's last hope. I admit that incision of the lung for a foreign body in it is only applicable to this or that exceptional case: the localization must be exact, the patient must be in danger of death: then, I think, you ought to do it.'

3. The proposal to reach the main bronchi from be hind is supported by those who have studied the surgical anatomy of the posterior mediastinum, and I have given their methods in Chapter xxii. It sounds so easy as one reads it. 'The bronchus can be easily felt by the finger: the incomplete rings are so characteristic that nothing else can be mistaken for it. The incision for removal

should be made in the long axis of the tube, and of sufficient length to permit the removal of the foreign body without laceration. The tube should not be closed: if this be done, it will surely open again: an iodoform tamponade, supplemented with drainage tubes, will meet the requirements of the case.'

Putting aside for the present the route advised by Truc, we have here two American surgeons, one attempting operation from the front, the other advocating it from behind. Let us contrast with their views the teaching and experiments of Dr. Willard, of Philadelphia[1]: and I make no apology for giving a full abstract of his work, because it seems to me of the very highest practical value. First, we may take his conclusions: next, the experiments which led to them.

1. The collapse of the lung, when the chest is opened, is an exceedingly serious and dangerous element in the operation, adding greatly to the previous shock, and threatening at once to overpower the patient.

2. The difficulties of reaching the bronchus, especially upon the left side, are exceedingly great: and the risks of hæmorrhage are enormous.[2]

3. Incision into the bronchus necessarily, after closure

[1] Dr. de Forest Willard, "Intra-Thoracic Surgery: Bronchotomy through the Chest-wall for Foreign Bodies impacted in the Bronchi." "Trans. Amer. Surg. Ass.," 1891, ix., p. 345. It will be noted that his experiments were not much concerned with the method of opening the posterior mediastinum without opening the pleura. But this method still involves the risk of frightful hæmorrhage: the opening of the pleura is only one of many dangers.

[2] 'In a dog, the aspects of the parts during life and after death are as absolutely different as they can possibly be. A bronchus which after death is easily exposed and reached I have seen, five minutes previously, absolutely enclosed with huge pulsating vessels, any one of which, if punctured, would seriously compli- the operation, if not causing death. The difference of the in life and in death can only be appreciated when seen.'

of the wound in the chest-wall, leads to increasing pneumothorax.

4. The delays in the operation from the collapse of the patient must necessarily be great. Rapid work is impossible, when the root of the lung is being dragged backward and forward at least half-an-inch in the efforts occasioned by air-hunger, and precision is almost impossible.

5. To reach the bronchus is sometimes feasible: but to extract a foreign body from it, and to secure the patient's recovery, is as yet highly problematical, and will require many advances in technique. The anatomical surroundings are those most essential to life.

I give an abstract of Dr. Willard's experiments on dogs: they show clearly that incision of a bronchus is an impossible operation.

1. Under the anæsthetic, before the operation was begun, the dog ceased to breathe, and could not be restored to life. The trachea was opened, and a pebble was passed down into the left bronchus. Search was everywhere made for it, both in the bronchus and in the substance of the lung, but in vain. Finally, it was found in the larynx.

2. Incision far back toward spine, so as to reach bronchus from behind: free bleeding from erector spinæ. Subperiosteal resection of fourth and fifth ribs, an inch and a half of each. Tracheotomy done, and a pebble carried down with the forceps, and dropped into the right bronchus. Pleura opened: lung immediately collapsed, and the animal's condition became so bad that it died before the bronchus could be opened. The pebble was clearly felt in the bronchus during the operation, but after death was found in the larynx.[1]

3. Incision far back on right side, two inches outside spine, so as to avoid erector spinæ: subperiosteal resection of one rib. Pleura opened: lung collapsed, and the animal

[1] 'By what means it had worked its way there could not be ascertained. Farier and Sabatier, in similar experiments on dogs, found that the objects were always expelled after tracheotomy (whether the animal were lying down, or upright), even when they had been pushed well down into the bronchus.'

nearly died. Artificial respiration had to be done again and again: it was not possible to keep him on his back: tracheotomy and introduction of a foreign body were therefore abandoned. Upper lobe of right lung drawn forward, bronchus cleared of vessels surrounding it, and incised for half an inch: very free hæmorrhage from wound of a pulmonary vein. This was ligatured, and incision in bronchus was closed with three catgut sutures. Dog did well for two days, then died: cause of death not known.

4. Incision in third left space, in axillary line: subperiosteal resection of four inches of fourth rib. Pleura opened, upper lobe of lung drawn out, and rush of air into pleura checked by passing lobe of lung through a slit in a sheet of rubber-tissue: bronchus exposed outside this sheet. It was bare of vessels, and was quickly and easily incised. One stitch was placed in the incision with a curved palate-needle. As the second stitch was being placed, a sudden movement of the root of the lung made the needle enter a pulmonary vein, and there was a gush of blood. The vein was seized and tied: but further attempts to close the wound caused further hæmorrhage: the blood ran into the bronchus, and finally the dog was killed.

5. Incision on the left side, subperiosteal resection of seventh rib (should have been a little higher): pleura opened, same use of rubber-tissue. Anterior aspect of left upper bronchus exposed, and thoroughly isolated, and free for incision, when the animal suddenly died.

6. Incision on the right side, subperiosteal resection of fifth rib: serious hæmorrhage from intercostal artery, finally stopped by ligature. Bronchus of first lobe inaccessible both in front and behind, being deeply concealed and covered with pulmonary vessels. Bronchus of second lobe reached, in front, and incised for one-third of an inch. Three catgut sutures successfully placed, but the animal had repeatedly to be resuscitated with artificial respiration, and died 15 minutes after the operation.

7. Incision on the left side, subperiosteal resection of fourth rib: pleura opened, immediate collapse of lung, and great shock. Bronchus of upper lobe found concealed by enormous pulmonary arteries and two huge veins which lay in front, completely covering it. These were carefully isolated, but the great depth of the bronchus made incision of it quite impossible, as the vessels could not be held out of the way. Bronchus of middle lobe exposed from behind: but aorta and pneumogastric lay upon it, so that incision seemed hopeless.

It was at last achieved: one suture was placed, the next tore out; and the dog, after repeated resuscitation, finally died.

8. Incision on the right side: resection of an inch and a half of fifth rib: pleura opened, upper bronchus exposed: bronchial and pulmonary veins pushed aside: very large vena azygos. Bronchus incised for one third of an inch: no sutures, so that effect of open wound of bronchus might be observed. Rapid pneumothorax, air soon bursting through superficial wound. When this was finally closed, pneumothorax became more intense, and soon ended in death. The slit in the bronchus acted like the valve of a force-pump.

These very valuable experiments plainly forbid all hope of our reaching and removing foreign bodies in the bronchi by any direct incision of them. It is true that one might possibly gain access to a bronchus through the posterior mediastinum without opening the pleura, or at all events without causing collapse of the lung: but the dangers of hæmorrhage are so great, and the uncertainty of the whole procedure so frightful, that the operation is hardly likely ever to be practised. And how can the surgeon explore the bronchus, or get a hold on the foreign body, through a button-hole in the bronchus deep inside the chest? How can he close his incision, even if he can make it? And how can he prevent infection of the mediastinum, if he leaves it open? These objections may be theoretical: but so is the operation.

Truc's method seems to me, on the whole, the least dangerous of the three. It is indeed hardly more than an early attempt to reach a suppurating cavity deep in the lung. There is not much difference between incising the lung to find a foreign body in it, and opening a deep gangrenous cavity caused by the falling of the stump of a tooth into the air-passages (see Dr. Strange's case, p. 310). It would be necessary to make a free resection, to shut off the pleural cavity by some such method as Roux's suture, given on p. 308; and to make

very careful search in the lung-tissue with a long fine needle. Probably the operation would fail. Possibly incision of the lung with a Paquelin's cautery might promote escape of the foreign body some time after the operation. It is in the lung that the chief harm is being done: it is the state of the lung that gives the indications for operation, if any sort of operation is justifiable.

Leaving these desperate cases, and their desperate remedies, we come to the general signs and course of foreign bodies in the air-passages, and to the results gained by tracheotomy and by exploration of the bronchi from the trachea.

General Signs and Course.

The list of the different things that have found their way into the air-passages is too long to be put here. Some of them, such as beans and other seeds, may swell and so become fixed: but the swelling of the mucous membrane of the bronchus is more to be feared than the swelling of the foreign body. The history of the accident must be very carefully considered. An enlargement of the bronchial glands may give signs like those of mechanical obstruction, and *vice versâ*; an abrasion of the œsophagus or of the trachea may cause misleading symptoms; or the period of quiet which sometimes follows the settling down of the intruder may be taken as evidence that it is not there at all. In all cases, a careful laryngoscopic examination must be made, and the surgeon should, if possible, get a duplicate of the thing, and see what he can learn from it: the hooks on a false tooth, or the shank on a button, or the wool on the end of a 'puff-dart' may help or hinder him in the removal of them. I had the privilege of helping Mr. Thomas Smith in the case recorded by him and Dr. Cheadle in the Transactions of the Medico-

Chirurgical Society for 1888: the obstruction was a metal pencil-cap. It was probable that the cap had gone down into the bronchus head foremost. A delicate probe, passed down to it and rotated, gave the feeling of being inside it. A fine laryngeal crocodile-forceps, with its blades roughed on their *outer* aspect, was then passed down into the cap, the blades were *expanded* inside it, and the cap was pulled out fitted tight over them. Or we may take, as another example of how much depends on the character of the foreign body, Dr. Rushmore's case, where a cork was impacted in the left bronchus, close fitting it. Tracheotomy having been done, with division of the second, third and fourth rings of the trachea, he attempted to suck out the cork with an air-pump: this had promised well in experimenting with a cork lodged in a piece of india-rubber tubing, but now failed altogether. Then loops of wire, and bougies with glue at the end, were tried in vain. Five days later he tried a corkscrew concealed in a slit tube, with two spikes movable between the screw and the tube. He got the spikes into the cork and then turned the screw into it, but the whole thing pulled out. Then the anterior operation was tried and abandoned. The patient died five days later with purulent hepatization of the lung. Two punctures were found on the cork, and a small piece of it was missing.

For the general character of foreign bodies in the air-passages, we have Dr. Weist's [1] careful analysis of no less than 1000 recorded cases. In America, the commonest intruder is a grain of American corn: of 177 cases, 66 ended in expulsion and recovery, 26 died without operation, and 85 underwent tracheotomy, of whom 66 recovered and 19 died. Water-melon seeds were the offenders

[1] "A Study of a thousand cases of Foreign Bodies in the Air-Passages." "Trans. Amer. Surg. Ass.," 1881-83, i., p. 117.

in 109 cases; 70 got well without operation, 5 died without it, and 34 had tracheotomy done, of whom 26 recovered and 8 died. Coffee-beans accounted for 59, the majority recovered without operation. The cases of 'miscellaneous' bodies were 371; of these, 263 went without operation, and 199, about three out of four, recovered: 108 had tracheotomy, and 77 recovered. His 1000 cases give a total of 93 deaths after tracheotomy, and in no less than 73 of these, the foreign body was never removed at all. In 5 of them, it was spontaneously expelled through the mouth some months after the wound had closed.

In 63 out of the 1000 it was removed by methods short of tracheotomy (forceps and frontal mirror 28, forceps alone 20, probang 2, wire-hook 3, finger 8), and of the 63 only 1 died. The intruder, in these 63 cases, was in the larynx in 39, and in the trachea in 3 only, in the remaining 21 its situation was not recorded.

The total number of operations[1] was 338, of whom 245 recovered and 93 died. The nature of the 'corpus delicti' in these 93 fatal cases was as follows:—

Foreign Body.	Fatal cases.	Body removed by operation.	Body not found or not removed.
American corn ..	19 ..	6 ..	13
Water-melon seeds	8 ..	0 ..	8
Beans	15 ..	0 ..	15
Coffee-beans ..	11 ..	5 ..	6
Other seeds ..	9 ..	1 ..	8
Miscellaneous ..	31 ..	8 ..	23

Finally, we have to note that in 10 of the patients, the voice was lost after the operation, and in 38 it was impaired.

[1] Laryngotomy 36, of whom 30 recovered and 6 died. Laryngo-tracheotomy 26, of whom 19 recovered and 7 died. Tracheotomy 276, of whom 196 recovered and 80 died.

Of course it is only the worst cases that come to operation, and the dressing and after-treatment of tracheotomy are better now than they were twenty or more years ago: still, these figures are to be carefully studied. They show that seeds and grains are not likely to do serious harm in the air-passages, and that our chance of finding them, if they do, is almost hopeless, and they prove the need of laryngoscopic examination, and of paying great attention to the character of the foreign body before deciding to operate.

The symptoms and physical signs of a foreign body in the air-passages are so variable, and belong so much more to medicine than to surgery, that I need not here quote long accounts of them; but I give the signs that were noted in the case of the pencil-cap in the left bronchus as a good instance of the accuracy of localization that may in some of these cases be attained. 'It was quite clear from the physical signs that the left lung was almost completely collapsed. The retraction of the side, the absence of movement, the rising of the stomach to the level of the nipple, the displacement of the heart's apex upward and to the left, showing extreme contraction of the lung—together with the impaired resonance and vibration, and the almost complete absence of respiratory sound—were conclusive on this point. The fact that a certain amount of air passed in and out of a portion of the upper lobe seemed to prove that the pencil-cap had passed to the extreme end of the left bronchus, and had therefore gone beyond its branch to the upper lobe of the lung.'

Of all the records I can find, this case comes first in skill, and forethought, and good judgment. From the physical signs the pencil-cap was exactly localized: a preparation was made of the lungs and trachea from the

dead body, with a similar obstacle put inside them. The one right way of grasping the intruder was carefully thought out before-hand, and the operation was as accurate as the reasoning that settled the exact method of it, and was at once successful.

The rule that the right bronchus is more often obstructed than the left is so often contradicted by facts that we must not lay stress on it. Of 30 cases given by Beleg, in 19 the left bronchus was obstructed; Bourdillat gives 26 right and 15 left; Gross, 24 right and 8 left; Cheadle, 14 right and 19 left; and Sanders, 23 right and 5 left.

The prognosis, if no operation be done, is so good in some cases and so bad in others that nothing can be said about it. A water-melon seed is a very different thing from a cork, or a tooth with hooks on it, or one of those needles with wool at the end that children use for the game of "puff-dart." Seeds, though they swell at first, become soft and broken afterward. Some bodies may be able to pierce the bronchi, and may thus become encysted in the lung, or may work their way out through it: others, without irritating or infecting the lung, may lie quiet even for many years and then be at last expelled through the mouth. A hard body may be missed with the forceps, because it is covered with thick tough mucus, as in the following case[1]:—

'Some years ago I was required to perform tracheotomy for the removal of an artificial tooth with its attachment from the air-passages. I was surprised at the ease with which I could pass through the trachea and reach both bronchi, especially the right. The search was long and tedious: I was groping in the bronchi, when the body was really at the seventh ring in the trachea. Not finding it in either bronchus, I again introduced the forceps a short distance, and slowly

[1] Dr. Hingston, of Montreal; Discussion on Dr. Willard's paper.

advanced them, now open, now closed. In this way I found and removed a *soft* body, which was the tooth entirely covered with thick tough mucus. It had been in the trachea three months.'

We need not delay over methods other than tracheotomy, save to note once more the great importance of laryngoscopic examination. The old plan of using snuffs and emetics was useless and dangerous. To turn the patient head downward and hit him on the back has in some cases produced the desired result; but, unless tracheotomy has already been done, this sort of treatment is so hazardous that it should never be attempted.

1 [1] 'On April 3rd, 1843, a gentleman, playing with some children, put a half-sovereign in his mouth, and it slipped behind his tongue: violent coughing and vomiting at once followed. After this he was easy for a few days, but on April 7th had troublesome cough, sputa tinged with blood, pain in right side of chest. For the next two or three weeks his cough was now better now worse. He could feel the coin move in his trachea, and could make it slip upward by inverting himself. On April 25th he was strapped on a swinging platform, and was tilted head downwards, and then struck on the back. 'The cough was so distressing, and the appearance of choking was so alarming, that it became evident it would be imprudent to proceed further with this experiment, unless some precaution were used to render it more safe.' On April 27th, Sir Benjamin Brodie did tracheotomy, and attempts were made that day and May 2nd, to reach the coin with the forceps, but it could not be felt. The wound was kept open, and on May 13th the patient was again put on the platform and struck on the back; 'presently he felt the coin quit the bronchus, striking almost immediately afterwards against the incisor teeth, and then dropping out of the mouth.'

2 [2] A girl, 10 or 12 years old, drew a metal bottle-cap into

---

[1] The famous case of Mr. Brunel: "Trans. Med. Chir. Soc.," 1843, viii., p. 286. His surgeons were Sir William Lawrence, Sir Benjamin Brodie, Mr. Stanley, Mr. Charles Hawkins, and Mr. Aston Key.

[2] Dr. Weeks, of Portland, Maine; Discussion on Dr. Willard's paper.

her air-passages: a few days later tracheotomy was done. 'I passed a long pair of forceps down and could feel the cap. I worked a long time—it seemed to me that it was an hour—but I failed to secure it. I then had the child suspended, and introduced the forceps with the patient in this position, and after a few attempts succeeded in securing the body.'

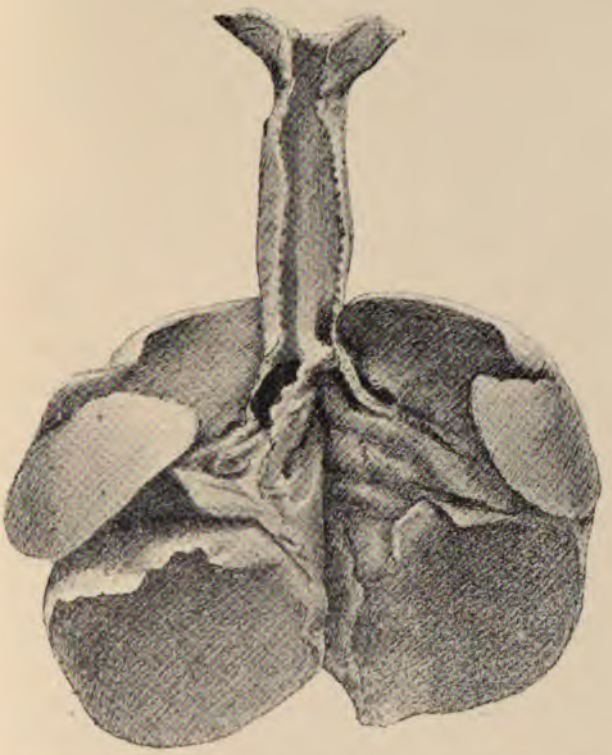
But it is not safe to try inversion of the patient without tracheotomy. And one case has been reported of death from hæmorrhage during it.

Plate XI. indicates the collapse of a part of the lung, and the impaction of the foreign body in the swollen mucous membrane.

Tracheotomy.

The incision should be made as low and as large as it can be without danger, and the cut edges of the trachea should be fastened in the wound. The surgeon should, if possible, practise beforehand with various kinds of forceps on the trachea and lungs of a dead body of the same stature as the patient. I cannot find that one is likely to succeed with blunt hooks, wire loops, or scoops; possibly a very small lithotrite might be found useful. Surgeons seem to be agreed that if the manœuvres are made very lightly and gently they may be continued for a long time. We cannot be bound by Gross's rule, that only three attempts should be made, each lasting only a minute: very gentle exploration may be carried on for a very considerable time without any additional risk to the patient. The surgeon must not forget to explore the larynx from below; he may possibly find the foreign body above his wound, not below it. Should he wholly fail to find or remove it, the trachea must be kept sutured in the wound, and no tube must be put in it, only the thinnest loosest layer of gauze must be laid lightly over it, and great care taken to keep the air of the room hot and moist.

PLATE XI.



The Lungs and Air Passages, with a foreign body in the right bronchus of a child, 5 years old. There was some collapse of the right lower lobe. (From a specimen in St. Bartholomew's Hospital Museum.)

Face

Inversion of the patient, further attempts to remove the obstruction, may ultimately succeed. Should everything fail, and should the lung become the seat of acute septic inflammation, it might be advisable to attempt to save the patient's life after the method advocated by Truc. We must remember also that if the lung is already badly damaged, suppuration or gangrene may attack it even after the obstruction has been removed.

I will not lengthen this chapter with more quotations. In those cases where operation is necessary, success, if it come at all, will come not so much from depending on the experience of others, as from carefully studying beforehand the case in all its aspects, from practice on the dead body, and from the ingenuity and readiness of the surgeon himself.

NOTE.—Mr. Godlee has lately read before the Medico-Chirurgical Society, a very valuable paper, "On the effects produced by the retention of foreign bodies for lengthened periods in the bronchial tubes." The following abstract of it is taken from the "Lancet," for March 28th, 1896. He quoted several cases as typical of the result that might be anticipated if foreign bodies of different sorts were retained for periods of varying length in the bronchial tubes.

1. A boy, aged 16, who inhaled the peg of a peg-top seven-and-a-half years before, and had developed bronchiectasis. Various operations were undertaken for its removal, and it was finally expelled through an opening made into one of the bronchiectatic cavities. The boy seemed to have recovered.

2. A boy, aged 6½, who inhaled a small ivory knob, which was retained for eight weeks. It set up extensive bronchiectasis, but there was nothing to suggest the presence of any one large cavity, and thus it did not appear that anything was likely to be gained by surgical interference. The boy

at first did not improve, but later reports were more favou able.

3. A boy, aged 4, developed bronchiectasis as the resu of inhaling the vertebra of a rabbit seven months before. cavity was opened. Ultimately, the bone was coughed u Eight years after the accident, much improvement had take place, but there was still evidence of a basic cavity.

4. A youth, aged 17, inhaled an ear of corn into on bronchus: there followed acute dilatation of the bronchi an gangrene of the lung, with burrowing of pus; and the cas ended in death.

5. A case of bronchiectasis, due to the lodging of a toot in a bronchus. Many attempts at removal failed, and th patient died of tubercle engrafted on to the primary diseas

In the discussion following Mr. Godlee's paper, man similar cases were mentioned. Dr. J. K Fowler observe that the lung-changes were often extensive, and that th bronchiectasis was usually of the fusiform variety, th tubes being thickened, and the surrounding lung indu rated. The symptoms usually followed a definite cours beginning with cough and expectoration, the latter be coming fœtid: then pleurisy and progressive emaciatior and later still diffuse broncho-pneumonia followed b gangrene.

CHAPTER XXIV.

THE "SURGERY OF THE HEART."

THE surgical treatment of pericardial effusions is perhaps the greatest triumph of all in the surgery of the chest, and it was won by the physicians more than the surgeons: by Trousseau in France, and by Clifford Allbutt in England. Though neither puncture nor incision of the pericardium were done for the first time in this country, yet we have, I believe, the best literature on the subject: the work of Steavenson, Ogle, Ewart, and many others; above all, Dr. West's admirable monograph, with its collection of 80 cases, in the "Transactions of the Royal Medico-Chirurgical Society" for 1883.

The surgery of the pericardium has naturally gone on the same lines as the surgery of the pleura. In 1819, Romero, of Barcelona, operated by puncture in three cases, two of whom recovered. The next great advance was in 1881, when Rosenstein, of Leyden, after twice puncturing a purulent pericarditis, laid open the sac and drained it: the patient recovered. In England, puncture was done by Jowett, of Nottingham, in 1827; Wheelhouse in 1866, and Teale in 1869; incision with drainage was done by West in 1882. For the history of the subject, and for experimental work on it, we have Trousseau's lectures, and a multitude of scattered writings, especially during the last few years.

But just as we have advanced from the pleura to the lung, so we were invited, some years ago, not to be content with operations on the pericardium, but to look

forward to a time when we should operate on the hea itself. We were told that 'heart-puncture and hear suture' were to be the next achievement of surgery; an it may be well to consider first what came of thes promises before we take the record of the treatment o pericardial effusions as we treat pleural effusions—th serous, by puncture or aspiration; the purulent, by in cision and drainage, with or without resection.

Now of 'heart-suture' we have first to note the fac that it has, so far as I know, only once been done i practice (see note at the end of this chapter); next, tha only the most strange and unlikely set of conditions coul ever bring about the need of it. It is quite true tha Block was able to pass sutures into the hearts of rabbits and found it a simple procedure, taking only three o four minutes; and it is true also that a wound of th heart, not immediately fatal, with hæmorrhage into th pericardium, may give the surgeon a hope of saving th patient's life by withdrawal of the effused blood by aspi ration or even by incision.[1] It is not impossible that th

[1] Thus, in 1881, Dr. Roberts, of Philadelphia, said: 'The tim may possibly come when wounds of the heart itself will b treated by pericardial incision, to allow extraction of clots and perhaps to suture the cardiac muscle.' Block's experiment were published in 1882; he found it possible, having made penetrating wound into either ventricle of a rabbit's heart, t take hold of the apex of the heart, and draw it forward, thu stopping the hæmorrhage and steadying the heart till the suture were put in. Dr. Joseph Bell ("Trans. Med. Chir. Soc. Edin.," 1894-95, p. 36) giving an account of a fatal case of a small woun of the heart, with distension of the pericardium with blood, says 'The youth had run for some distance before he died. If th surgeon had dilated the wound and turned out the clot, he woul not have required to suture the wound in the heart; and h might, by draining under antiseptic precautions, have saved th man's life.' A similar case, where this was done, and th patient recovered, is given in the chapter on 'Wounds of th Heart.'

surgeon, having incised the pericardium along the track of the external wound, might see a wound still bleeding on the surface of the heart, and might pass a fine suture through it: but I think the cases given in the chapter on 'Wounds of the Heart' are on the whole against it. A small heart-wound would not need it; a large one would not give the chance for it. Puncture of the heart, on the other hand, has been done a great many times, either by accident or on purpose; it has also been made the subject of much experimental work. Three arguments are put forward on behalf of it: first, that simple puncture of the heart with a needle may restore its action after it has stopped; next, that the withdrawal of blood from its cavities may save life in cases where it is overloaded and distended with blood which it cannot of itself expel; last, that it may save life when air has reached the heart through a wound in a vein. Let us begin with the experiments on animals, and the question of their applicability to surgery, and then take the cases where the heart has been punctured by mistake.

Experiments on the mammalian heart, to show how its action may be restored or relieved, have been of three kinds: stimulation by pressure, stimulation by needling, and aspiration of blood from one of its cavities.

It is certain that the heart, after it has ceased to beat, may be restored to action by simple handling of it, or even, as Panum has noted, by blowing on it. To those who make experimental study of the heart, it is known that free handling of it does not in any way arrest its movements. Block found, in his experiments on suture of the heart in rabbits, that he could start contraction, after it had stopped, by gently squeezing the heart; and it was a similar observation that led

Watson[1] to his very important experiments on puncture and aspiration. These facts have no direct bearing on surgery; but at least they show that if the surgeon be ever brought face to face with the necessity of touching the human heart, he may do this without fear of hindering its action.

Needle puncture of the heart, with or without aspiration of blood from it, has been very carefully studied, with numerous experiments, by Watson and Senn.[2] Watson's aim was to find a means of averting death in chloroform-syncope. Senn had in view the relief of the heart when air has passed into it from a wounded vein. There is no room in this book for more than a short notice of their work; but this at least may give some idea of it.

Puncture in Chloroform-Syncope. Watson's Experiments.

Of Watson's sixty experiments on dogs, some were simple punctures; others were punctures with a hollow needle, letting out a few drops, or a few ounces, of blood; but on some occasions no blood flowed through the needle. In none of the experiments was blood aspirated through it. In some, artificial respiration was performed.

---

[1] Having killed a dog with chloroform, he exposed the heart, four minutes after the cessation of respiration, and found it motionless in diastole; his assistant, at this moment, seized the heart between his thumb and fingers, and it began at once to act; the contractions soon became full and regular, and lasted for some minutes; they were again excited by the same method, but soon ceased. Watson, 'An Experimental Study of the Effects of Puncture of the Heart in Cases of Chloroform Narcosis,' "Trans. Amer. Surg. Ass.," 1887, vol. v., p. 275; with a report of sixty experiments.

[2] Senn, 'An Experimental and Clinical Study of Air-Embolism,' "Trans. Amer. Surg. Ass.," 1885, vol. iii., p. 197; with a record of thirty-nine experiments.

Forty of the animals had suffered some severe injury, twenty were healthy. The anæsthetic employed to arrest the heart's action was always chloroform; in fifty cases it was given rapidly and without air; in ten slowly, with a liberal admixture of air. In forty-seven out of the sixty, the moments were carefully noted at which the respiration and the pulsation stopped; in forty-four, the heart stopped before the breathing; in one, they stopped at the same moment; in two, the heart went on for half-a-minute or a minute after the breathing had stopped.

The results obtained by puncture were very striking. Out of sixty experiments, in two, and in two only, did the heart fail to respond: in one of these, the needle, on its way to the heart, got stuck in the lung; in the other, puncture was not made till four minutes after the heart had ceased to beat. In twenty-two, no use was made of artificial respiration, and the average interval of time between cessation of the heart's action and introduction of the needle, was one minute and twenty seconds: in all of these the heart responded to the stimulation. The punctures were made as follows: right ventricle, 38; left ventricle, 6; right auricle, 6; apex, 2; and in 5 the needle passed into one of the venæ cavæ. Ten out of the sixty animals, though their hearts had ceased to beat, were yet restored to life by the puncture, and completely recovered; one of them, indeed, after two experiments, recovered twice. The punctures in the ten cases that recovered, were all made into the right ventricle, except one into the right auricle.

To emphasize these ten recoveries, we may note that forty of the dogs had already received various injuries, and were to be put to death on this account; and six of the ten recoveries occurred among the twenty that were healthy. The dogs were still alive when Dr. Watson pub-

lished his report. In none of the sixty was the puncture made less than a minute after the heart's action had ceased. The cases where blood was let out did better than those where simple puncture was performed. In no less than thirty-two, there was an interval of time between the puncture and the return of the heart's action: it ranged from a few seconds to three minutes. Puncture of the auricle was, in several cases, followed by considerable hæmorrhage into the pericardium: this did not happen in any of the thirty-eight experiments where the ventricle was punctured.

We must admit that no results of this kind have been obtained in surgery. Dr. Kinloch tried it in a case of chloroform-syncope, without result. Dr. Dana ("New York Med. Rec.," Feb. 1883) states that he has often punctured the heart in animals, and by so doing has sometimes stimulated and never checked it; but he got no results in two cases where he did it in practice. Dr. Corwin (*Ibid.*, March 1883) admits that he never saw any good come of this method of restoring life, though he has practised it, or seen it practised, many times. But these were not cases of chloroform-syncope.

It is not wholly free from risk. Fischer, of Breslau ("Deutsch. Ztschr. f. Chir.," 1875) practised it in a case of chloroform-syncope without success, and the *post mortem* examination showed the coronary artery punctured in two places, and the pericardium full of blood. It is said to have been the cause of death in more than one case; and the silence of recent years shows clearly that there have been no signal successes with it.

Still, we cannot simply set aside Dr. Watson's facts. They are not concerned with anything but chloroform-syncope, and the results he obtained apply to this condition alone. In a case of apparent death under

chloroform, where it was certain that the heart had stopped, it would be at all events better than nothing to take the last hope offered by puncture. A fine aspirating needle, without the aspirator, should be used; or even, if this were not to hand, a simple long needle. It should be put in through the fourth space, an inch and a half or two inches to the left of the middle line.

ASPIRATION IN AIR-EMBOLISM. SENN'S EXPERIMENTS.

Senn's work in 1885, on the entry of air through the veins into the heart, contains not only a valuable collection of cases, but also an account of thirty-nine experiments on various animals. In ten of these, having driven air along one of the jugular veins into the heart, he then withdrew the air and blood, by means of an aspirator, from the right ventricle. In seven, having driven air into the heart, he withdrew it by means of a catheter passed down the wounded vein into the right auricle. In two, he drove the air straight into the right ventricle through a needle, and then withdrew it. Three out of the ten animals, and three out of the seven recovered, though their condition had appeared past hope of relief. He used an aspirating needle 2 mm. in diameter, carefully sterilized; he made his vacuum as soon as the needle was through the skin, so that he might find the cavity of the ventricle without going too far into it, and directed the needle upward so as to make a more valvular opening into the cavity, and to avoid injuring the lining membrane of its opposite wall. While we must admire the skill and thoroughness of Dr. Senn's work, we must also note that it was severely criticized when he brought it before the American Surgical Association; and indeed there is a wide difference between the condition produced in an animal by inflating its heart

with air, and the entry of air into a vein during a operation. To the question, 'What symptoms, after a has entered a vein, indicate the need of puncture an aspiration of the right ventricle'? he replies that in mediate collapse, with complete or almost complet arrest of the heart's action, shows that the heart has bee suddenly distended with air and paralyzed; subsequer tumultuous, rapid, or intermittent action, with churnin sounds heard over the cardiac area, rapid breathing, pallo and blueness of the lips, shows that the air has alread begun to invade the pulmonary artery; and in either c these conditions the aspirator should be used. But th records of this disaster show so many recoveries withou any treatment of this kind, and so many cases c immediate death where there would be no chance c trying it, that we can hardly expect ever to find a use fo it. Doubtless, if one should hear these churning sounds and see the whole picture of the air-distended hear as Senn has drawn it, he would be justified in attemptin this method; but it is likely that Senn's work will remai rather a monument of experimental science than a con tribution to the necessities of surgery.

Aspiration in Simple Distension. Westbrook's Case.

A third novelty of surgery, also from the New World was proposed in 1882 and 1883, that one should punctur the heart for simple distension, such as occurs in acut pneumonia with impeded circulation through the lungs that one should, in short, bleed the patient a few drachm from the heart, instead of a few ounces from the arm In 1883, the following extraordinary sentence was writte on behalf of this metho l: 'Further experimentation i heart-puncture for the relief of cardiac distension an

pulmonary engorgement is requisite, but it is probable that it will soon become a well-recognized surgical procedure in selected cases.'[1] The case where this method was adopted occurred in November, 1882[2]: it was that of a man, aged 50, with very severe pneumonia of the right lung. 'The struggle was evidently hopeless; it was plain that there was no longer any chance of recovery.' It was decided to aspirate the right auricle: a very fine needle was passed through the third right intercostal space, close to the sternum, to a depth of two inches; but only a few drops of blood came into the bottle. It was now pushed a little further, and touched hard calcareous matter, and had evidently punctured the aorta. It was drawn a little way back, and about a drachm of blood was got from the auricle. Half-an-hour later, a large needle was used, and about three ounces of blood was withdrawn without trouble. The patient was relieved, but died the next morning. *Post mortem*, three or four ounces of thin blood-stained fluid in the pericardium.

I can see no reason why this method should ever be employed in these cases, nor what advantage could be gained from it that would not more safely be obtained by venesection.

Accidental Puncture of the Heart.

We have now gone through several proposals for suture, aspiration, and puncture of the heart, and have got small encouragement to adopt them. We come next

---

[1] Dr. J. B. Roberts, a paper read before the College of Physicians of Philadelphia, Jan. 3rd, 1883.

[2] Dr. Westbrook. On 'Abstraction of Blood from the Right Heart.' "New York Medical Record," 1882, vol. ii., p. 705.

to a curious group of cases,[1] where the heart itself has been punctured, unintentionally, during some operation on the pleura or the pericardium.

1. In 1872, in the case of a child five years old, with pericardial effusion, the surgeon, having withdrawn the fluid, accidentally punctured the right ventricle, and withdrew from it about 6¼ ounces of pure venous blood. This was followed by pallor, sweating, and failure of the pulse; but the child recovered. He died five months later from long-standing dilatation and valvular disease of the heart.

2. In 1873, a girl, aged 11 years, having inflammation of the heart and pericardium, with hæmorrhagic effusion, was treated with puncture of the pericardium on eight occasions during thirty-four days. On two of them, the heart was slightly wounded, but no bad result was observed. She died three days after the last operation.

3. In 1875, a woman, aged 27, with signs of enlarged and diseased heart, and of pericardial effusion, after rheumatic fever, was treated with puncture with a fine trochar and cannula. 'We knew that we had a very large heart to deal with; nevertheless, the rapid increase in the dull area after admission to Hospital, and the bulging of the chest-wall, together with apparently considerable muffling of the sound of the heart, seemed almost certainly to indicate fluid in the pericardium.' The puncture was made in the fourth space, about half-an-inch to the left of the sternum; a gush of dark blood came through the cannula, and it was observed to move with the heart. It was quickly withdrawn: only about a drachm of blood was removed. 'The patient, who before the operation was almost moribund, rallied after it, expressed herself as being relieved by it, and lived for nearly four weeks, the distension of the heart having gradually diminished.'

4. In 1877, a woman, suffering from dilatation and mitral disease of the heart, with orthopnœa, pulmonary congestion, and general anasarca, came under the care of two homœopathic doctors, who diagnosed pericarditis with effusion. 'They attempted aspiration, with the result that the needle

[1] For references, see "Trans. Med. Chir. Soc. Edin.," 1894-95, vol. xiv., p. 24; "Clin. Soc. Trans.," 1875, vol. viii., p. 169. In Dr. West's tables, there are one or two other cases where the heart was wounded in paracentesis of the pericardium.

penetrated the ventricle, and ten to fifteen ounces of blood were withdrawn; the urgent symptoms were for a time relieved. They did not recognize that they had penetrated the heart, and made a second attempt, after some days' interval: but the patient died in a short time. At the *post mortem*, the marks of the punctures were distinctly visible.'

5. In 1883, a man, aged 40, was admitted to Hospital with acute nephritis and congestion of the lungs. His chest was much deformed by a lateral curvature of the spine; the apex-beat was an inch or more above the left nipple, and there was thought to be considerable enlargement of the heart. 'The question of hydro-pericardium being raised, the needle of a veterinary hypodermic syringe was introduced at a point where there was dulness on percussion, and but little or no movement apparent on palpation.' The barrel of the syringe was immediately filled with dark venous blood, and the needle was felt to move slightly with the heart. No change, good or bad, followed this occurrence. The patient died next day. The *post mortem* examination showed a small ecchymosed spot about an inch above the apex; no hæmorrhage into the pericardium.

6. In 1894, Dr. Sloan reported a case of very great interest. A girl, aged 19, during a severe attack of rheumatic fever, complained of oppression and præcordial pain, and was found to have a well-marked friction sound over the heart. A few days later, this disappeared; then it returned, together with a well-marked systolic murmur, and the patient's general condition became slowly hopeless: she suffered excruciating pain, sickness, a hacking cough, pulse 120-140, feeble and dicrotic, respiration 30-50. 'The livid, anxious countenance, the pallor of the lips, the working of the alæ nasi, the dilatation of the veins of the neck, and increased general restlessness, all indicated rapid effusion into the pericardium.' There was marked increase of cardiac dulness —fully an inch to right of sternum, and up to second space —the friction-sound was still heard, the heart-sounds were feeble. On June 13th, 1894, she suddenly collapsed, and the heart and breathing both stopped. 'I seized the aspirator, and plunged the needle into the fourth space, about half-an-inch to the left of the sternum. To my astonishment, from eight to ten ounces of pure blood flowed rapidly into the bottle and then suddenly stopped. As I was slowly withdrawing the cannula, to my surprise the heart made first a feeble irregular movement, then gave a sudden strenuous jump, and finally, like a pendulum regaining its swing or a

runner his stride, it started to beat again in the race for life.' She slowly recovered, and was restored to health.[1]

7. A patient, suffering from ulcerative endocarditis and dilated heart, presented signs also of pericardial effusion; puncture was made with an ordinary exploring syringe, and the surgeon found that he had punctured the heart. Blood was drawn off with the syringe; the needle was at once withdrawn; the patient died in half-an-hour. The *post mortem* examination showed the pericardium distended with blood, and a small wound in the right ventricle.

These cases, though they are full of interest, do not give us much guidance. We hear of the successes, but not of the disasters. A non-penetrating puncture can do nothing but harm; a penetrating puncture, with abstraction of blood from the right ventricle has been known to do good to a dilated and failing heart; but we do not hear of the cases where it did harm; and even in those one or two cases where it did good, we must still ask whether venesection might not have had the same result.

We have now gone through the various methods of suture, aspiration, and puncture of the heart, suggested by experiment, practised of set purpose, or inflicted by chance. The quest has not been very successful; but we have, I think, found reason to believe that puncture of the right ventricle may be useful in desperate cases of chloroform-syncope: and that suture of a wound of the heart is at least not impossible.

NOTE.—A wound of the heart has lately been treated by free exposure and suture by Cappelen: the patient, a man 24 years old, was stabbed in the fourth left space in the axillary line. He went home alone, and about an hour later was found lying in a pool of blood. He was

[1] There is no room here for the details of this case. The reader should consult Dr. Sloan's vivid account of it, in the "Transactions of the Medico-Chirurgical Society of Edinburgh," 1894-5.

brought to Hospital unconscious: external hæmorrhage had stopped, pulse could not be felt, but faint heart-sounds were heard to right of sternum: left side of chest did not move in respiration. After a stimulant injection of camphor, chloroform was given, the wound was enlarged, the fourth rib was resected, and the pleura was found filled with blood, part fluid, part coagulated, compressing the lung: it was estimated at 2½ pints. After its removal the lung expanded, and was found not wounded. A piece of the third rib was now resected, and a wound of the pericardium was seen bleeding freely. This was enlarged, the sac was found filled with clots, and a wound nearly an inch long was found on the left ventricle, causing the bleeding. It was sutured, and an artery was tied: after this the bleeding stopped. The needle was brought halfway through during a contraction and then dropped; and when the heart dilated after a second contraction, the point of the needle was grasped and it was drawn the rest of the way. The suturing was made very difficult by the rhythmic movements of the lung, which covered the whole field of operation, and by the movements of the heart, but these were perfectly regular and quiet all the time. The clots in the pericardium were removed, so far as possible: the pulse after operation was very quick and feeble, but improved after a hypodermic injection of saline solution. The patient sank and died two-and-a-half days later. The *post mortem* examination showed that a large branch of the coronary artery had been wounded: the wound had begun to heal, but there was evidence of pericarditis. The knife had passed through the fold of the pleura without wounding the lung.

Cappelen published this case in March of this year. See Epitome, "Brit. Med. Journ.," May 23rd, 1896.

CHAPTER XXV.

PERICARDIAL EFFUSIONS.

We need not go outside this country for the literature of the surgery of pericardial effusions. There is such a wealth of it in our own language, that my difficulty is to know how best I may present some small part of it in this chapter. The introduction of the operation into England, and the careful study of the exact indications for it, and of the best way of doing it, have been the work of the physicians, not the surgeons: it is one of the greatest triumphs of surgery, but the surgeons did not win it for themselves.

I will endeavour, from the chief medical writings about it,[1] to set down those rules, methods and difficulties that we must bear in mind in the surgical treatment of these cases. We have to remember that the need for operation may arise suddenly, and that we should be as ready to perform it as we are to do tracheotomy.

History.

The history of paracentesis pericardii is a good comment on John Hunter's advice—"Don't think; try." The operation was advocated by Riolan (1649) and Senac (1749), and many other writers, long before it was

[1] Ogle, "Clin. Soc. Trans.," 1873, vi., 131; Steavenson, "St. Bart. Hosp. Reports," 1881, xvii., 217; West, "Med. Chir. Soc. Trans.," 1883, lxvi., 235; Sir Grainger Stewart, "Med. Chir. Soc. Edin. Trans.," 1884-85, iv., 53; Ewart, "Brit. Med. Journ.," Mar. 21, 1896. References to isolated cases are too numerous to be put here.

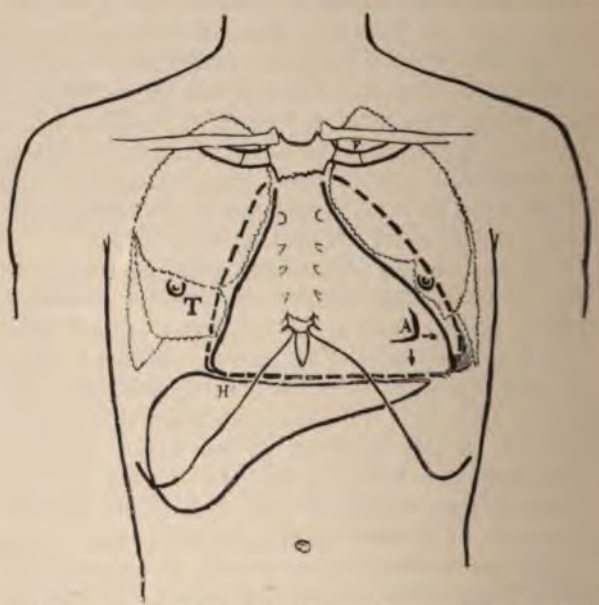
first performed by Romero of Barcelona (1819) in three cases, two of whom recovered. In Germany, Schuh (1839) was the first who did it; in Russia, Karawajew (1839); in France, the honour is due to Trousseau of establishing it past criticism; in England, Sibson (1854) and Clifford Allbutt (1866-70) were its first advocates; and in 1873, Dr. John Ogle was able to collect records of seven cases where it had been performed in England and Scotland. The operation was now generally recognized: Hindenlang in 1879, Roberts of Philadelphia, in 1880, West in 1883, and Sir Grainger Stewart in 1885, drew attention to it in Germany, America, England, and Scotland; and we have a great store of long treatises on it, with a multitude of recorded separate cases.

The advance to free incision and drainage, for the cure of purulent pericardial effusion, was made by Rosenstein of Leyden, in 1881, and in this country by West, in 1882.

A year before Romero's operations, Skielderup punctured the pericardium by means of a trephine-hole in the sternum; Malle (1871) did the same thing, but there is nothing to be said in favour of this way of doing it. Both Romero and Trousseau made an incision down to the pericardium, exposed it, felt it, and not till then punctured it, or picked it up with the forceps and incised it. This has been called a coarse way of operating, but it seems to me to have a good deal in its favour. In the first place, the needle is less likely to go too far and wound the heart[1]: in the next, the surgeon might avoid

[1] 'If there be not a large amount of fluid, and if the cannula and trochar be passed into the pericardium with a jump, or the patient make a sudden movement, a vein on the surface of the heart may be wounded. It is best to make a small incision through the skin, and to pass the trochar gradually into the pericardium, without the jump that is unavoidable when it has to be thrust through the skin.' Mr. Sheild, "Med. Soc. Trans." 1895, xviii., 188.

the common danger of puncturing a dilated heart in mistake for a pericardial effusion. In some cases, an 'exploratory incision' might be safer than an 'exploratory puncture.' We should only be applying to the pericardium a rule which is followed in general surgery.



Outlines of the total and of the absolute dulness in pericardial effusion. *A*, position of apex (fifth space). Arrows show dulness extending below and beyond it. *T*, patch of tubular breathing below right breast. *F*, upper edge of first rib, made accessible to touch by lifting of the clavicle. From Ewart, "Diagnosis of Pericardial Effusion."—"Brit. Med. Jour.," Mar. 21, 1896.

Diagnosis.

As one reads the literature of this subject, one finds innumerable references to the difficulty of diagnosis between extreme dilatation of the heart and pericardial

effusion, and many cases where mistakes have been made, even by Trousseau himself and others of like standing. Perhaps, in such cases, a carefully-planned exploratory incision would be safer than puncture; at all events, it may be useful if I put here the signs of pericardial effusion given by Dr. Ewart in the very valuable paper that he has just published.[1] They apply only to such large effusions as are likely to need surgery. He has kindly let me make use of one of his diagrams (page 386).

FIRST SIGN. *Considerable Extension of the Lateral Boundaries of the Total Area of Dulness.*—The border of the lungs does not coincide with the lateral boundaries of the distended sac, but overlaps it. It is the superficial resonance of their fringes, and the puerile vesicular murmur arising from them, which are apt to mislead us. A careful percussion will guard us against this danger, and will enable us to delineate a complete outline of the sac.

SECOND SIGN. *Great Extension of the Absolute Dulness: the Sternum Absolutely Dull.*—A much enlarged heart, aneurysm, abscess, or mediastinal new growth, would likewise completely deprive the sternum of its normal resonance; this change, therefore, by itself is not absolutely diagnostic, but is of great importance in conjunction with other changes.

THIRD SIGN. *Depression of the Liver.*—Any cardiac enlargement, and any considerable pulmonary distension, will produce more or less displacement downward of the hepatic line of absolute dulness; but in no other condition, except pneumothorax and intrathoracic sarcoma, is the depression of the liver so marked, at least in the middle line, as in large pericardial effusions.

FOURTH SIGN.—*Dulness between the Fifth and Sixth Right Costal Cartilages; Rotch's Sign.*—This is the result of the accumulation of fluid within the right corner of the sac, a very valuable sign, but not absolutely diagnostic. A case has been recorded of tricuspid stenosis, with enormous dila-

[1] Ewart, "Practical Aids in the Diagnosis of Pericardial Effusion, in connection with the question as to Surgical Treatment." "Brit. Med. Journ.," Mar. 21, 1896.

tation of the right auricle: such a condition might also give this dulness.

FIFTH SIGN. *The Lower Angle of the Pericardial Dulness projects toward the Right.*—Instead of the normal convexity of the edge of the right auricle, downward *and inward* toward the ensiform cartilage, the outline of a pericardial effusion is that of a bag of fluid spreading out at its base; the lowermost level is also that of the greatest width of dulness from side to side, and the lowermost angle projects outward.

SIXTH SIGN. *The Left Lower Angle of Dulness; the Relation of the Apex-Beat to this Angle.*—Here again the pyramidal shape of the dulness gives a prominent angle toward the left, instead of the somewhat rounded-off outline which is normal. But this is not an absolute guide, since any condition that prevents the natural overlapping of the lung over the heart may give a like result. On the other hand, the relation of the apex to the left angle of dulness is of great diagnostic value. In all cases of enlargement of the heart, or displacement of it to the left, the apex-beat is at the extreme left limit of the dulness, and at its lowest level. This is not the case in pericardial effusion. The apex cannot be *felt*, in cases where there is much effusion, but it will be *heard* beating at a point somewhat inside and above the boundaries of dulness.[1]

SEVENTH SIGN. *The Upper Edge of the First Rib can be felt on palpation, as far as its Sternal Attachment.*—This points to a raising of the clavicle, not only in its outer but also in its inner portion, and to a relaxation of the ligament between it and the first rib. I have rarely seen this sign in the absence of pericardial effusion, except in some cases of considerable enlargement of the heart.

EIGHTH SIGN. *The Posterior Pericardial Patch of Dul-*

[1] 'I cannot avoid warning you against a remarkable misconception, hitherto perpetuated by the text-books, as to the alleged elevation of the apex within the effusion even as high as the third interspace. That an impulse can usually be felt there is not surprising, but this impulse is not of the apex of the heart, but rather of its base. If we drop a heart, or a thin membranous bag with some blood in it, into fluid of the usual density (1018) of a pericardial effusion, it will sink to the bottom. The heart, therefore, even in diastole, cannot float in serum. Again, the heart is tethered to the bottom of the pericardium by the attachment of the vena cava inferior. I have in some cases detected a lowering of the heart's apex in pericardial effusion.'

ness.—A patch of marked dulness over the base of the left lung behind, extending outward from the spine, usually not quite so far as the line of the angle of the scapula, and ceasing abruptly with a vertical outer boundary. Upward, it does not usually extend higher than the ninth or tenth rib, and here again its boundary is abrupt. Its shape, therefore, is square, quite unlike that of any dulness arising from pleuritic effusion. The breath-sounds over it are absent, and the voice-sounds feeble. In a case of very large pericardial effusion, this patch of dulness may extend a little way to the right side.

NINTH SIGN. *Tubular Breathing below the Right Breast.* This sign is not constant, but should be looked for in severe cases; it is usually heard about the nipple line, and sometimes in expiration only.

TENTH SIGN.—*The Posterior Pericardial Patch of Tubular Breathing and Ægophony.*—Immediately below, or a little to the left, of the lower angle of the scapula, there is a patch of well-marked tubular breathing and ægophony, about 2 inches in diameter. This, though not so important as the eighth sign, is very commonly, if not always, present in cases of considerable pericardial effusion. It also occurs in pleural effusions.

ELEVENTH SIGN. *The Secondary Pleural Effusions.*—These, probably due to pressure, are among the most common complications of pericardial effusion in its later stages. The pleural effusion frequently begins on the right side; but it often, at last, occurs on both.

TWELFTH SIGN. *The Pulse in Pericardial Effusion.*—The *pulsus paradoxus*, *pulsus cum inspiratione intermittens*, is an important sign, but is characteristic of mediastinal rather than of pericardial disease, and cannot be regarded as diagnostic of the latter. I have frequently observed in pericardial effusion an opposite condition of the pulse; a large slapping beat, with very sudden impact and quick collapse of the wave; in fact, it is Corrigan's pulse, almost of a typical kind, though never so extreme as in well-marked aortic regurgitation.

Such are the twelve signs of a large pericardial effusion given by Dr. Ewart, in addition to those that are more familiar. He lays special stress on the fifth, sixth, and ninth; and all of them refer only to such large effusions as are likely to need surgical treatment.

Indications for Operations.

But there is no clear rule, how large the effusion must be before the surgeon shall intervene. Dr. Percy Kidd[1] has recorded the case of a man, aged 40, with pericardial effusion due to rheumatism, whose condition was such that for several days he thought to recommend paracentesis; the day he made up his mind to do so, the patient began to amend, and recovered without operation. In Dr. Ogle's case, a man aged 34, the area of cardiac dulness reached the enormous size of 6 inches by 7. 'The agony and distress of breathing, and the sleeplessness, were so great that the indications for operation were clear, and we were on the point of tapping the pericardium. Still, bearing in mind the possibility of untoward circumstances resulting from the operation, I hesitated in having recourse to it; and the event proved that the delay was justifiable. Had there been positive and manifest interference with the oxygenation of the blood, or had anasarca been occasioned, I should undoubtedly have had the operation performed.'[2]

From a surgical point of view, it is hard to see what case can ever need paracentesis if this did not. The exact amount of pressure that the heart can stand is unknown to us. The removal of even a few ounces of fluid may change the whole aspect of the case, and if the effusion be purulent or sero purulent, there is no hope that it will be absorbed. These three reasons must appeal to all surgeons in favour of operation before the effusion has become so large as it was in Dr.

---

[1] Kidd, "Med. Soc. Trans.," 1895, xviii., p. 189; Ogle, *loc. cit.*

[2] This patient, also, recovered without operation. We must note that the case was reported in 1873, when the fear of 'untoward circumstances' was greater than it is now.

Ogle's case; but this is hardly a question for them to decide.[1]

The whole subject is fully discussed in Dr. West's account of 80 cases (1819-1883) of pericardial effusion treated by operation. Of 71, where the sex of the patient was known, 57 were males, and 14 females. Of 67, where the age was known, 7 were under 10, 20 were under 20, 28 under 30, 7 under 40, 1 under 50, 1 under 60, and 3 under 70. The diseases with which it was associated were as follows[2]:—

1. *Rheumatic Fever.*—Eleven cases: seven made a complete recovery, one lived 6 months, one lived 6 days; in one, the operation was not done till the patient was moribund; and in one, the trochar penetrated the right ventricle, and the patient died in a few minutes. Only a few ounces of fluid were removed, except in one case where the amount removed was two pints. Very great relief was given by the operation.

2. *Phthisis.*—Thirteen cases, of which seven had also pleuritic effusion. In all, the pericardial effusion was serous; in most of them, only a few ounces were removed; but in five, the amounts were 22, 27, 28, 35, and 49 ounces. Four were so far relieved as to be put down as recoveries; two lived over two months, one nearly a month, two died a few hours or days after the operation.

3. *Scorbutus.*—Nine cases, all males. In all, the effusion

---

[1] Sir Grainger Stewart (*loc. cit.*) points out that if there are indications that the heart itself has become weakened by the general inflammation, one ought to operate even though the effusion be not very large; and to be especially careful not to draw off too large a quantity of it.

[2] These cases come to 79 in all; the 80th case, which is put at the end of Dr. West's tables, but came too late to be incorporated in his paper, was a case of pyæmia, under the care of Sir William Savory, with abscesses in the shoulder and thigh, and left pleural effusion. This was twice tapped, then a free incision was made through the fifth space in the anterior axillary line. No fluid was found, but the pericardium was felt to be distended, and was opened then and there through the same wound. Twenty-four ounces of pus were let out, and the patient was much relieved: he died a fortnight later. "Trans. Path. Soc.," 18 4.

was hæmorrhagic; in all, the amount of it was very large—from 1½ to 5 pints. Six made a complete recovery; one died a few hours after operation, two at later periods after it.

4. *Pleurisy.*—Six cases: in two of them, one of which was a case of empyema, the pericardial effusion was purulent. Only one recovered, but most of them were relieved.

5. *General Dropsy.*—Five cases: two from morbus cordis, both died; two from nephritis, both recovered; one from general bronchitis, recovered.

6. *Pneumonia.*—Two cases: in both, the effusion was purulent, and probably of a pyæmic origin.

7. *Miscellaneous.*—Three cases followed exposure to cold, a surgical operation, and a new growth in the mediastinum; and one was referred to an injury.

8. *Unassigned.*—Seventeen cases: six recovered, eleven died. In six, a *post mortem* examination was made; in four of these, the pericarditis was found to be due to tubercular disease[1]; in one there was double hydrothorax; in one, a pericardial effusion with adherent pleura.

9. *Purulent Pericarditis.*—Twelve cases: all fatal,[2] except two that were treated by free incision. All males: out of ten, whose ages were recorded, seven were between 10 and 20 years old, and the oldest of all was only 31. Six of the twelve were probably pyæmic; two were associated with empyema, though in one of these the empyema was subsequent to the operation. In none of them was the character of the fluid diagnosed before the operation, nor do there seem to have been any physical signs by which this could have been done.[3] In some, the operation was repeated more than once—in one, six times. The quantity of pus removed varied a good deal, but the average was higher than with serous effusions.

The results of operation, thus admirably set forth, are full of encouragement, when we consider the hopeless

---

[1] In the cases of tubercular pericarditis recorded in Dr. West's tables, the effusion was serous, never purulent or hæmorrhagic.

[2] In Ponroy and Frémy's case (1870) the effusion, though purulent or sero-purulent, was cured by aspiration. Twenty-eight ounces were removed. The case is given in Dr. Ogle's paper, and is No. 32 in Dr. West's tables.

[3] It is to be remembered that the temperature may be normal, even with pus in the pericardium.

condition of these patients. Two points are especially to be noted—the great relief given by it in cases where it still failed to save life, and the good results obtained by the withdrawal of even a small quantity of fluid.

Operation.

We have to reckon with the fear of wounding the heart. In one of the eighty cases, two ounces of blood came through the cannula, and the patient died in a few minutes: the right ventricle had been torn, about the middle of its anterior aspect. In another (1868) ten and a half ounces of blood came through the cannula, the left pleura was also wounded, and the patient died in two hours; more than half a pint of blood was found in the pleura. In three others, the heart was slightly wounded, but no harm was done; in one of them, a girl, 11 years old, where puncture was made on eight separate occasions, the heart was wounded twice.

The place of puncture has been made the subject of much debate; every space from the second to the eighth has been used for it. Steavenson wrote in favour of the third space, because the fluid distends the pericardial *cul-de-sac* at the root of the aorta. Rotch has advocated the fifth space, on the *right* side, about half-an-inch from the sternum. Dr. West's cases give the following sites of puncture: in 30, the fifth space; in 20, the fourth; in 3, the sixth; in 3, the third; in 1, the seventh; and in 1, the eighth. We can hardly be surprised that this last was a 'dry tapping.' And in 3, the third or fifth *right* space was chosen. But we need not let these exceptional procedures disturb the general rule. We must keep to the outer side of the internal mammary artery, and the inner side of the lung; and, unless there be some special

reason for going elsewhere, the best point is the fifth left space, one inch from the sternum.[1]

It may be dangerous to give an anæsthetic. I once, when a student, saw death follow the use of a small quantity of chloroform, in the case of a boy with pericardial effusion, just as the exploring syringe had been inserted: the heart was not wounded. Bouveret[2] quotes a case of death from shock, during an attempt to puncture the pericardium:—

A young man, who during eight years had suffered four attacks of acute rheumatism, with heart-complications, was admitted to Hospital with extreme dyspnœa, and signs of pericardial effusion. An aspirating needle was passed through the third right space (!) an inch and a half deep. No fluid escaped; the needle was felt to move with the movements of the heart. The patient cried out, drew a deep breath, turned livid, then pale, and died. The *post mortem* examination showed that the needle had passed into the anterior mediastinal space, and had become fixed, not in the heart, but in the pericardium, which was very thick and hard, and almost universally adherent; there was a huge sero-purulent pericardial effusion, nearly a quart, untouched.

Here we have two deaths, one under chloroform, the other without it. On the whole, I think cocaine (not only applied to the skin, but also injected under it) would be safer than a general anæsthetic, or it might suffice to freeze the skin; but there is no general rule on this point.

In every case, an exploratory puncture must first be

---

[1] "If the pleura be adherent, the puncture may be made safely much further out, and even in the sixth space."—Dr. West.

It is certainly bad advice that one should go as near the sternum as possible: Dr. Drury, of Dublin, has shown by numerous dissections that by doing this one would be in great danger of wounding the internal mammary artery or its vein. See "Brit. Med. Journ.," May 30th, 1896.

[2] Traité de l'Empyème. The reference is to "L'Union Médicale," 1878.

made. For the withdrawal of the fluid, aspiration is not necessary: there is no question here of negative pressure, such as may make a failure of simple puncture of the pleura without aspiration. Whatever instrument is used, it must be a very fine one. If the aspirator be used, of course the needle must be guarded with its cannula, and no vigorous suction must be made.

Shall the surgeon withdraw only a few ounces of the effusion, or all of it? It is true that the withdrawal of only a few ounces may suffice not only to give relief, but also to set up absorption of the remainder. And it has been urged that withdrawal of the whole of a large pericardial effusion may cause syncope. But we cannot argue from a pleural to a pericardial effusion; and I can find no evidence that syncope is likely to follow the withdrawal of the whole of the fluid, however much it may be, from the pericardium.[1]

A small incision must be made through the skin; the needle must not be driven inward with a stab; and, if the aspirator or an aspirating syringe be used, a vacuum should be made before the pericardium is reached. If there be much œdema of the soft parts, it may be hard to hit off the space. In Ponroy and Frémy's case, owing to this difficulty, the needle was thrust *through* one of the costal cartilages, instead of going between them, and got plugged with a wad of cartilage, so that the effusion escaped not through but by the side of it.

Finally, we come to the treatment of purulent pericarditis by incision and drainage. It may be that

[1] In a very interesting case of purulent pericarditis, treated three times by aspiration, and finally by incision and drainage (Dr. Dickinson, "Clin. Soc. Trans.," 1889, xxii., 48), the patient became faint during aspiration on the second occasion, but no mention is made of his fainting on the third occasion, a week later, when a still larger quantity of fluid was withdrawn.

incision will come to be used for some cases of effusion not purulent. After all, we can hardly draw a line between making an incision through the skin to ease the passage of the needle, and making an incision down to the pericardium. However this may be, it is certain that a purulent effusion must be incised and drained. The pus sometimes contains fibrinous clots, and these have been known to give trouble.[1] In one case, irrigation was employed during the operation, on account of them. Unhappily, the fluid syringed into the pericardium collected within it, and the patient died during the operation. In this case, a piece of costal cartilage was resected, and the pericardium, before it was opened, was sutured to the chest-wall.

It is not likely that the surgeon will proceed straight to incision and drainage; he will probably first have punctured or aspirated the effusion once at least. But should he begin with incision, he must remember that the heart may be adherent here and there to the pericardium. I need not quote at length the records of this operation[2]; it should be done as simply as possible, and no more should be done than is absolutely necessary. Drainage during the days after operation might be helped by getting the patient to lie face downward. It must be kept up for a considerable time. In Rosen-

---

[1] 'I find on looking over reported cases, and I know from observation, how frequently the pus in this form of pericarditis is of a flocculent, shreddy character.' Mr. R. W. Parker, *loc. cit.* Dr. Ewart ("Med. Soc. Trans." 1895, xviii., p. 189) mentions a case of purulent pericarditis treated by aspiration only, where the needle passed into a quantity of fibrin, and never reached the mass of the fluid.

[2] Dr. West gives Rosenstein's case, with his own; other cases are recorded by Dr. Dickinson and Mr. Parker ("Trans. Clin. Soc.," 1889), and Dr. O'Carroll ("Brit. Med. Journ.," May 30th, 1896).

stein's case, the wound was healed in three weeks; in Dr. West's, the cavity was drained from Sept. 17th to Oct. 14th; in Dr. Dickinson's, from July 22nd to about Sept. 2nd. A narrow, sharp-pointed bistoury should be used to open the pericardium, and the admixture of a little air with the escaping pus does not prove that the lung has been wounded, for the air may pass in and out of the pericardium with the movements of the heart. Incision of the pericardium need not be a separate operation apart from puncture of it. In Dr. West's case, the two were done together, and the cannula served as a guide for the bistoury. It would indeed be best, in a case where the effusion is known to be purulent, either to make incision at once, or at least to be prepared to convert the puncture made by the aspirating needle into an incision large enough to admit a good-sized drainage tube.

Malignant disease of the pericardium may so exactly imitate the symptoms and physical signs of pericardial effusion as to lead to operation. This occurred in a case recorded in the "Transactions of the Pathological Society," for 1882. The trochar, passed inward for an inch-and-a-half, found no fluid, and received no impulse from the heart: several punctures were made in vain. Finally, a probe, passed down the cannula, came against a very hard substance. The *post mortem* examination showed the pericardium to be the seat of a sarcomatous growth.

CHAPTER XXVI.

INTRATHORACIC NEW GROWTHS. HYDATID CYSTS. ACTINOMYCOSIS.

Malignant Disease.

It is impossible here to attempt an account of all the forms of new growth that may arise within the chest. We must keep within the limits of operative surgery, and consider this great subject only so far as it is related to surgical interference. But, before we come to instances of operations done formally and of set purpose for the relief of some of these diseases, we have to note a very important group of cases where the diagnosis has been wrong, and the surgeon has mistaken a new growth for a pleural effusion, or *vice versâ*.

It cannot often happen that an effusion should be mistaken for a new growth: but the following cases[1] show how this may be done:—

1. A very decrepit old man, 75 years of age, applied for admission to Hospital. He was suffering extreme shortness of breath, there was absolute dulness over the whole right side of the chest in front, absolute loss of breath-sounds and of vocal vibration, hardly any displacement of heart or of liver, several hard enlarged glands above the right clavicle, no history of illness, no pain, only weakness. "I felt sure it was a new growth, but puncture showed it was a large hæmorrhagic pleural effusion."

2. A young man, aged 20, was admitted to Hospital with symptoms of pressure in the mediastinum. The diagnosis was made at first of mediastinal tumour, and later of medias-

[1] Fräntzel, "Ziemssen's Handbuch," "Krankheiten d. Pleura," 1875, and Dr. West's paper on "Purulent Pericarditis," *loc. cit.*

tinal cyst. Puncture let out a quantity of clear serous fluid, which coagulated, and deposited cholestearin. The tapping was repeated several times: he died exhausted four years and a half after the beginning of his illness. The *post mortem* examination showed that what had always been regarded as a mediastinal cyst was really a large chronic pericardial effusion.

Or traces of an old pleurisy may be present in the chest of a patient in whose case there is some special reason for fearing malignant disease:—

A patient, aged 34, whose right breast I had removed for cancer, showed me a small recurrent nodule near the inner angle of the scar. There was also reason to fear that the pleura was diseased: for over the lower part of the lung, about the axillary line, there was a faint creaking sound on respiration, as if from some thickening of the pleura: and the movements of that side of the chest, and of the lung, were slightly impaired. But it was possible that these signs might not be due to cancer of the pleura. Where the breast had been, there was now a thin rigid stretch of skin; this might cause the loss of movement and of expansion, and the friction-sound might possibly be due to an old pleurisy, or to some simple thickening of the pleura after operation. I removed the recurrent nodule, and she is still, a year later, in good health.

But of course the commoner error of diagnosis is to mistake a new growth for an effusion, and probably there are few physicians of really great experience who have not made this mistake once, or more than once.[1]

A girl, aged 17, came under my care in January 1894, with subperiosteal sarcoma (myxo-chondro-sarcoma) of the lower end of the *right* femur, and I did an amputation through the middle of the thigh. I saw her afterward from time to time during 1894, and she kept in good health: once she complained of some pain in her *left* side, but this soon passed off. Just a year after the operation, January 1895, she was seized

[1] 'Three times at least' says one of them, 'I have been distinctly wrong in diagnosing pleural effusion where intra-thoracic tumour was present, and many times my doubts have only been removed by the results of exploration.'

with a sharp pain in her *left* side, and shortness of breath, and her medical attendant found all the physical signs of a pleural effusion; but she had no cough, no shivering, and but little pain. After some weeks at home, she was admitted to Hospital under the care of one of the physicians. The heart was pushed far over to the right of the sternum, and there was every sign of a huge effusion into the left pleura. The veins over the left side of the chest were not dilated, the left lower limb was not œdematous. Nothing but blood was drawn on aspiration, but a flake of tissue came away in the eye of the needle, which under the microscope showed small round cells. A few days later, under ether, an incision was made through the pleura, and came down on a solid growth. She nearly died during this small operation; for several minutes her breathing was almost at a standstill, all the accessory muscles of respiration appearing to be tugging at the ribs without lifting them. The use of oxygen revived her; she lived about a week longer, without much pain, and the oxygen never failed to relieve her dyspnœa. *Post mortem*, there was a huge mass of osteo-sarcoma filling the whole left side of the chest, and showing the print of the ribs, diaphragm, and left kidney, like plaster run into a mould. Only the uppermost part of the lung remained, and this was hollowed out into a cyst full of blood. The disease had invaded the anterior mediastinum, the base of the right lung, the lower ribs on the right side, and the spine. There was also recent fibrinous pericarditis.

In the two following cases[1]—which, like my own,[2] are examples of sarcoma of lung after sarcoma of bone of lower limb—the diagnosis was made easy by the patient coughing up fragments of the growth.

1. A man, aged 21, underwent amputation above the knee joint, in February 1887, for a hæmorrhagic myeloid sarcoma in the head of the left tibia. In June of the same year, he coughed up, without pain, a dark-red mass the size of his

[1] Hüber, "Ueber Lungensarkom." "Zeitschr. f. Klin. Med.," 1890, p. 341. In medullary cancer, whitish fragments, like 'morsels of cooked veal,' have in one or two cases been coughed up. For references, see Moutard-Martin, "Étude sur les Pleurésies Hémorrhagiques," 1878, p. 52.

[2] See Dr. H. B. Meakin's paper on "Sarcoma of Lung," "Path. Soc. Trans.," 1895.

finger-tip. A fortnight later, another somewhat larger mass; a week later, another, with some blood. Henceforward this coughing up of fragments of the growth, with hæmoptysis, became more frequent. He had a little pain in his left side when he coughed, and he was losing flesh. On August 22nd, he was admitted to Hospital. His respiration was quiet, regular, and the same on both sides. There was slight dulness on percussion over the left interscapular space, and the breath-sounds here were somewhat loud, with well-marked râles heard mostly during inspiration. No enlarged glands, no tenderness over the ribs, no fever, occasional cough with hæmoptysis. August 27th, he coughed up an ounce and a half of bright frothy blood, with two dark reddish-brown masses, about the size of the end of one's thumb. These contained giant-cells, and large single cells with active nuclei. September 2nd, hæmoptysis, nearly two ounces, with two similiar masses. There was never, at this time, any fever. September 26th, hæmoptysis, more than half-a-pint, with a large mass of the growth. Exploratory puncture drew off some turbid blood-stained fluid; no cells were found in it. From September to November, he had six attacks of hæmoptysis, with expulsion of fragments of the growth; as a rule, the hæmorrhage *followed* the expulsion. In November, a growth appeared in the right gluteal region. His temperature became hectic, and he died exhausted at the end of the month. The *post mortem* examination showed huge enlargement of the left lung with a mass of dark-red growth, filling the lung from root to surface, breaking-down centrally, cramming the main bronchus, and the main artery of the lower lobe. The right lung also, its bronchi and vessels, were invaded, and there was a secondary growth in the left occipital lobe of the brain.

2. A boy, aged 16, underwent amputation for osteo-sarcoma of the left knee-joint. Three years later, he was taken ill, with the general appearances of rheumatic fever, but got well in about a week. Ten days later he had a similar attack, and this time he complained of pains in the left side of the chest. Four days later he had a slight hæmoptysis, and a few days afterward he coughed up what looked like a long thin blood-clot. He got better for a time, and left the Hospital; but in a few weeks he was re-admitted with pain, fever, hæmoptysis, and pleural effusion. A similar strip of tissue was coughed up, and was found to be round-celled sarcoma. Before his death, he had on four occasions coughed up fragments of the growth.

These three cases may serve to show that we must always bear in mind the possibility of malignant disease, if a patient, who has in past years undergone operation for it, shows signs of trouble in the chest.[1] We must also make careful microscopic examination of the sputa, though as a rule, cancer-cells are not to be found in them; but they may be stained with blood.[2] And very careful search must be made for some unsuspected primary growth. Cases have been recorded, for example, of cancer of the lung secondary to cancer of the vagina, the stomach, the pancreas, one of the ovaries, or one of the suprarenal capsules.

The absence of fever may suggest that the case is one of malignant disease, not of pleuritic effusion. But in the last stages of rapid malignant disease, either in the lung or elsewhere, there may be fever of a hectic type: or the patient may be feverish from an infected pleural effusion *plus* malignant disease. And he is especially likely to be feverish if he is a child.

1. A little boy, 3½ years old, was taken ill in March, with slight feverish symptoms, and signs resembling those of

---

[1] Börck ("Deutsch. Ges. f. Chir.," 1890) collected notes of 87 cases of sarcoma of the femur treated by amputation at the hip-joint. He was unable to find one among all of them where it was certain that the disease did not recur within three years. I have only once amputated through the hip-joint for this disease. The patient was in good health when I last saw her, four years after the operation. A recent paper by Mr. Butlin and Mr. Colby, "St. Bart. Hosp. Rep.," 1895, shows that out of 40 cases of sarcoma of the femur, only 3 were alive three years after amputation.

[2] They may have a peculiar character, the blood being so intimately mixed with thin mucous or serous fluid that the sputa look like red-currant juice. See Burrows, "Trans. Med. Chir. Soc.," 1844, and Kidd, "St. Bart. Hosp. Rep.," 1883, xix., 227. One finds them described as 'thin reddish mucus resembling red-currant jelly,' or as 'at first mucus streaked with blood and clots of blood, but latterly more uniformly bloody, and of a peculiar pink colour.'

pleurisy of the left side. He gradually became worse, till there was complete dulness over the left side, with remittent fever. On April 14th, an exploratory puncture drew off only some blood-stained serum. Three days later, the eighth rib was resected in the axillary line, and a solid growth was found filling the pleural cavity. On April 20th he died, and the *post mortem* examination showed a huge mass of myxo-sarcoma arising from the left pleura.[1]

2. A boy, aged 12, after four months' illness (pains in the chest, cough, and latterly hæmoptysis) was admitted to Hospital in June, with signs of malignant disease in the left side of the chest, and died at the end of September. His temperature exhibited a very marked rise every morning, often to 102 or 103, falling every evening to normal, *e.g.*, during June the daily rise and fall ranged through 6·8 degrees, the usual difference between the highest and lowest temperatures in the 24 hours being 4 or 4·5 degrees. During this period he sweated profusely.

In his notes on this second case, Dr. Church refers to other similar instances of fever during the course of lymph-adenoma of the mediastinum. In one of them, a girl 17 years old, the temperature for two months was often 102 or 103, but the fever became less as the disease advanced toward death.

Nor can the diagnosis between malignant disease and pleural effusion be made by noting the presence or absence of pressure on the chest-wall. In the later stages of malignant disease, there may be retraction of the chest-wall; but the exact opposite to this may happen. There is no constant rule in this matter, and if effusion and malignant disease are both present together, the signs of the former may wholly mask those of the latter.

Putting aside such evident indications as a history of some previous operation for malignant disease, or the presence of a new growth in some other region of the

[1] Hofmokl, "Chirurgie der Pleura und der Lungen," 1890. Dr. Church, A Case of Intra-thoracic Tumour, "St. Bart. Hosp. Rep.," 1878, xiv., 242.

body, or the expectoration of fragments of the tumour, we have no sure or constant sign by which to know whether we have to deal with pleural effusion or malignant disease. It is of course easy to think of those distinctive characters that we should expect to find in a solid growth and not in an effusion. 'The area of dulness is, as a rule, less regular. It is not in all cases most marked at the lowest level of the pleura. Its upper level does not alter when the patient changes his posture. It does not stand higher at one time, lower at another, like a pleural effusion.'[1] But the literature of surgery contains so many examples where the one was mistaken for the other, that there is plainly no sure method of diagnosis in these cases.

We come then to exploratory puncture as the best guide toward recognizing the disease. If no fluid comes out, the needle-point must be carefully examined: a small fragment of the growth may be found sticking in it. If only a few drops of blood are drawn into the exploring-syringe, and the needle does not seem to move freely in a cavity, our fear of malignant disease must be heightened. But, if we take those cases where pleural effusion and malignant disease are both present together, what is likely to be the character of the effusion under these circumstances?

The answer to this question is given in Moutard-Martin's admirable monograph on 'Hæmorrhagic Pleurisies,'[2] and his work should be carefully studied. He collected notes of 42 cases of cancer of the lung, or of the

[1] Fräntzel, "Ziemssen's Handbuch." See also Dr. Poore, "Lancet," April 6th, 1895, and Dr. Martin, "St. Bart. Hosp. Rep.," 1865, vol. i., p. 262, for good accounts of the almost insuperable difficulty of diagnosis in some instances of intra-thoracic malignant disease.

[2] "Étude sur les Pleurésies Hémorrhagiques, Néo-membraneuse, Tuberculeuse, et Cancéreuse," Paris, 1878, p. 162.

pleura, or of both together; in some of them the disease was primary, but in the majority it was secondary. Out of the 42, in 37 there was no effusion, in 6 it was serous, and in 1 only it was sanguinolent, and in this case only at the second puncture.[1] To these 42 cases, collected from the "Bulletins de la Société Anatomique," he added cases recorded in other journals, and from the whole collection of more than 200 cases he finds that, on an average, in malignant disease of the lung or the pleura, effusion is present in 3 cases out of 8; when present, it is serous in 2 out of 3, and hæmorrhagic in the third. The surgeon must not expect to find cancer-cells in the fluid thus withdrawn: the search for them has very rarely been successful.[2]

An analysis of 19 cases of malignant disease of the lung or mediastinum (Victoria Park Hospital, 1886-1892) by Dr. Vincent Harris,[3] gave the following diagnostic results: In every case there was more or less difficulty of breathing. Pain was well-marked in only a few; cough was present in most, if not all, and in many was spasmodic and distressing. Only in a few were the sputa at all tinged with blood, or the character of the voice changed. In two, there was dysphagia; in five, some localized œdema. Inequality of the pupils, or of the radial pulses, was rarely observed. Only one or two of the cases showed fulness of the side of the chest, or of some intercostal spaces, or below the clavicle. The

[1] The reader will observe that $37+6+1=44$ not 42. I can only suppose there is a misprint in the original.

[2] Dr. R. G. Hebb, in a case of primary cancer of the pleura, drew off a pint and a half of blood-stained effusion, and with the microscope found one stray cell from the growth. "Path. Soc. Trans.," 1893, p. 5.

[3] "Intra-Thoracic Growths," "St. Bart. Hosp. Rep.," 1892, vol. xxviii., p. 73. In nearly every case the disease was primary sarcoma.

most constant sign was the area of absolute and resisting dulness, irregular in size and shape, merging into the præcordial dulness, and not altering with any change of position of the patient. The onset of the disease was in most cases very insidious; and, in two or three, there were continued fever and occasional night sweats.

Pleurisy with effusion occurred in several cases; gangrene of the lung in two; pericarditis, with blood-stained effusion, in two; obliteration of veins or arteries in two or more; pneumonia in three.

The pathology of the intra-thoracic growths is not here our concern: nor are pathologists wholly agreed regarding their origin; whether, for example, a diffuse malignant growth can arise in the endothelial cells of the pleura; whether we can draw a valid distinction between sarcoma and lympho-sarcoma. We have to consider only what hope can be offered to these cases by surgery. The most that can be done, and, so far as we can see, that ever will be done, is to withdraw the effusion. The one or two procedures of a more serious nature that have been recorded have been rather matters of chance than formal operations. How great relief may be given by aspiration is shown by a case recorded by Sir William Broadbent[1] of withdrawal of two quarts of deeply blood-stained fluid from the chest of a man, aged 76, who was able, for more than six months afterward, to be about and at work, in spite of his disease; and by Dieulafoy's case, where aspiration was done twenty-five times. It is advisable to draw off the fluid slowly, and not to feel bound to remove it all. Apart from the danger of causing hæmorrhage from the growth or from its adhesions,

[1] "A Case of Rapid Effusion of Bloody Fluid into the Right Pleural Cavity, at the age of 76."—"Clin. Soc. Trans.," 1878, vol. xi., p. 136.

aspiration has once or twice in these cases been followed by that profuse serous expectoration, which has been described in Chap. xiv. The quantity of fluid may be very large—even 6 or 7 pints. Should the effusion become purulent or semi-purulent, it may be necessary to employ incision and drainage. And, if I may judge from one case where I tried oxygen, the administration of it is likely to give great relief in the later stages of extensive malignant disease of the chest.

Dermoid Cysts.

Dermoid cysts have been recorded in the lung and in the anterior mediastinum, and have been treated by operation. Out of 42 cases of mediastinal new growth given by Rumpf,[1] 33 were sarcoma or carcinoma, 4 were fibroma, and 5 were dermoid. Roser cured a case of dermoid cyst of the mediastinum, gaining access to it by trephining the sternum. Langenbeck cured one by puncture and injection of iodine. The celebrated case of dermoid cyst of the lung, where Mr. Godlee laid open the cyst, removed the processes growing inward from its walls into its cavity, and drained it, is recorded in the "Transactions of the Medico-Chirurgical Society" for 1889, with references to several similar cases. Only a few instances of this most rare disease have been recorded, but at least we may note its existence, and the fact that it has been several times successfully treated by operation. We must note that a dermoid cyst of the anterior mediastinum may transmit the impulse of the heart. In a case recorded so far back as 1823,[2] the cyst

[1] 'Ueber Neubildungen im Mediastinum.' "Inaug. Diss. Freiburg," 1894.

[2] Dr. Gordon, "Case of Tumour in the Anterior Mediastinum, containing Bone and Teeth." "Trans. Med. Chir. Soc.," 1825, vol. xiii., p. 12. The patient was a young woman, 21 years old.

presented itself as a 'small round tumour, below the sternal extremity of the left clavicle, about the size of a nut, pulsating regularly and strongly. From its appearances and situation, it was pronounced, at the consultation which took place on the case, to be an aneurysm of the aorta or of the arteria innominata.' It finally pointed and broke, letting out only serous fluid. The patient died about a year and a half after the disease had begun to show itself.

Hydatid Disease.

Next to the liver, the lungs and pleuræ are the most common seat of this disease. Out of 100 cases of hydatid cyst ("Melbourne Medical Record," March 6th, 1875) in 70 the liver was affected, in 12 the lungs, and in 18, other parts of the body. Out of 74 cases reported by Dr. McGillivray,[1] 65 were of the liver, and 9 of the lungs. Whether the upper or the lower portion of the lung is more often affected, is a question that has been answered differently by different writers.

The disease may arise either in the lung or in the pleura, or it may invade the chest from the liver. Out of 31 fatal cases, Neisser[2] found 11 where it began in the pleura, 8 where it began in the lung, and 12 where it broke into the chest from the liver. Out of 11 fatal cases, Maydl found 3 where it began in the pleura, 4 where it began in the lung (in 2 of these it had burst into the pleura), and 3 where it burst into the pleura from the liver; in 1 case its starting-point was not made out.

In a few cases, more than one cyst has been found in

[1] See Dr. Greenfield on a "Case of Hydatid of the Lung," "Clin. Soc. Trans.," 1877, vol. x., p. 103.
[2] Neisser, "Die Echino-Kokkenkrankheit," Berlin, 1887.

the thoracic viscera; in a few others, the disease has again begun to grow, long after the patient had been cured.

Cases of hydatid of the heart have been from time to time recorded. There is an excellent drawing of this rare condition, at its worst, in the "Transactions of the Medico-Chirurgical Society" for 1832.[1] In some cases, sudden death from failure of the heart has been noted; in Mr. Evans' case, the patient, aged 40, for five or six weeks before death, suffered pain, dyspnœa, fainting fits, vomiting, and palpitation. 'The pulse was so rapid as to be countless, having the feel of a continued vibration of the vessel, rather than of a pulse; the carotids and other large vessels also vibrated strongly. The motion of the heart was sudden, jerking, and violent; its force seemed to increase under the pressure of the hand. It was felt over a large extent of the chest, and below the sternum.' In a case lately reported in the "Lancet,"[2] there were no premonitory symptoms of any kind; a man was sitting smoking and talking, and fell and died in a few minutes. The *post mortem* examination showed a mass of hydatid cysts embedded in the wall of the left ventricle. In Mr. Price's case (1821), a boy, ten years old, fell and died in a few minutes, having seemed in perfect health up to the time of his death. The *post mortem* examination showed a large hydatid in the muscular substance of the heart, pericardial adhesions, and about two ounces of dark fluid in the pericardium.

The diagnosis of hydatid disease of the lung or of the

[1] Herbert Evans, "Case in which a cyst containing hydatids was found in the substance of the heart." "Med. Chir. Soc. Trans.," 1832, vol. xvii., p. 507. Another case is recorded in the Society's "Transactions" for 1821.

[2] "Hydatids of the Heart," W. H. E. Knaggs, M.D., "Lancet," Jan. 4th, 1896.

pleura may present very great difficulties, and it has often been mistaken for other diseases, *e.g.*, pleural effusion, bronchiectasis, or tubercular cavity. Or hydatid disease and empyema may both be present together. The occurrence of hæmoptysis[1] at an early period in the patient's illness, or in greater quantity than one would expect in other diseased conditions presenting similar physical signs and symptoms, may perhaps lead the surgeon to the right diagnosis; and the sputa must be carefully and repeatedly examined. With exploratory puncture, we come to consider the operation for this disease, and the chances of recovery without operation.[2]

Neisser (1887) in 62 cases of hydatid of the lung, left without operation, found as follows: 25 recovered, or were relieved, after the cyst had opened into the air-passages; 1 recovered, after it had opened into the bowel; 23 died without either natural or surgical relief; 12 died in spite of the cyst having opened into the air-passages; and in 1 case, death followed the breaking of it into a vein. He puts the mortality of the disease, left to itself, at 58·7 per cent.

Madelung (1885) gives a more favourable view of the natural end of these cases. Out of his collection of 19 instances of hydatid of the lung, without operation, 10 recovered, 3 were relieved, after the cyst had opened into the bronchi, and 6 died.

Davaine (1877) agrees with Neisser: two-thirds of the cases left to themselves end in death.

Hearn (1875) collected no less than 144 cases: of

[1] Two cases of profuse fatal hæmoptysis are recorded by Dr. Curnow and Dr. Percy Kidd ("Path. Soc. Trans.," 1883 and 1885). It is especially likely to follow the expectoration of large pieces of cyst-wall.

[2] For references, see Richerolle, "Chirurgie du Poumon," Paris, 1892.

these, 62 recovered, and 82 died. Of the 62 that recovered, 45 were cured by bursting of the cyst into the air-passages, 5 by puncture, and 12 by incision.

Lehmann (1882) gives 8 cases, of which one, and one only, recovered; and this one recovery was due to operation.

It is plain that the mortality of hydatid disease of the lung, left to itself, is somewhere between 50 and 60 per cent., to say nothing of the years of illness which some of these patients have to undergo.

The rupture of the cyst into the bronchi may of itself be a frightful ordeal, even if it does not end in death. Richerolle quotes the case of a man, aged 22, whose illness began in October, 1888, with pleurisy of the right side, followed by effusion which was absorbed. In March, 1889, the effusion recurred and was again absorbed. In April, hæmoptysis set in, and he was put under treatment for tubercular phthisis, and later was sent first to La Bourboule and then to Algiers. By December, he was suffering intense dyspnœa, constant cough, and profuse blood-stained expectoration, and was very feeble. On Dec. 31st he coughed up nearly a pint of watery fluid; then blood came with it; then pure blood. He coughed up in this way 3½ pints of pure blood; lost consciousness, and remained unconscious for four days. Later, he suffered violent painful attacks of cough, and the sputa were those of gangrene. A fortnight after the rupture of the cyst, he coughed up a quantity of membranes, and then began to improve. A year later, he was in good health, but the sputa were still purulent.

The statistics of operation are in strong contrast with those of non-interference. In 1885, Thomas, an Australian surgeon, collected 32 cases of hydatid of the

lung, treated by free incision, with no less than 25 recoveries; he puts the mortality of the disease, left to itself, at 54 per cent.; treated by puncture, at 27; treated by resection and incision, at 16. Lopez, of Lisbon, collected 36 cases, of which no less than 31 were cured by surgical intervention.

Incision, not puncture: the results of simple puncture or aspiration are very bad. Maydl (1891) collected 16 cases treated by simple puncture; of these, no less than eleven died, or 69 per cent.; five of them died of purulent pleurisy or of pyo-pneumothorax; six directly of the puncture, within a few hours or even a few minutes.

The following cases illustrate the disastrous results that may come of simple puncture or aspiration of a hydatid cyst of the lung[1]:—

1. A man, between 50 and 60 years old, was admitted to the Prince Alfred Hospital, Sydney, with great shortness of breath, and the case was correctly diagnosed as one of hydatid of the right lung. An aspirating trochar was passed inward in the axillary line at the level of the nipple; a few ounces of clear fluid ran into the bottle; a gush of clear hydatid fluid came from his mouth, he fell back, and died in a few minutes. *Post mortem*, nearly the whole of the right side of the chest was filled by a hydatid cyst; and the opposite lung had been swamped by the fluid running out by the side of the trochar, and so up the right bronchus and down into the left lung.

2. A boy, 9 years old, was admitted to Hospital after a fortnight's illness, with signs as of pleural effusion on the left side. A large aspirating needle was put in just below the angle of the scapula, and a few drachms of clear watery fluid escaped through the needle as the aspirating-bottle was being adjusted to it. But when the stopcock was turned, no fluid ran into the bottle; clear frothy fluid began to pour out of the boy's mouth, three or four ounces in a few seconds.

[1] For references, see "St. Bart. Hosp. Rep.," 1892, vol. xxviii., p. 238; "Clin. Soc. Trans.," 1891, vol. xxiv., p. 73; Richerolle, *loc. cit.*; and Heydweiller, "Ueber Lungen-chirurgie," Berlin, 1894.

His breathing became difficult, his lips blue, and his pulse feeble; he became restless, and distressed, emphysema ran all over the side and the neck, and he died in a few minutes. *Post mortem*, in the lung was a collapsed cavity, a little smaller than one's fist, containing a single collapsed hydatid cyst; a main bronchus opened by several perforations into the cavity, and the lower lobe of the lung was collapsed and airless.

3. A man, aged 26, after a month's illness (dyspnœa, localized pain in the lower part of the right side) presented signs of hydatid disease of the right lung. An exploratory puncture was made; two hours later, he sank and died. *Post mortem*, there was found a hydatid cyst, of a capacity of 4½ pints, between the lobes of the right lung; a large bronchus opened into it.

4. A young man, aged 19, after two years' illness (cough, shortness of breath, evening rise of temperature) presented signs of hydatid disease of the right side of the chest; and the diagnosis was made certain by exploratory puncture. Aspiration was then made through the fifth space, and 36 ounces of fluid were withdrawn. This was followed by sudden distress and oppression, paroxysmal cough, and expectoration of serous fluid, which was found to contain hooklets. Later, he became feverish, and the sputa became purulent. Nineteen days after aspiration, the cyst was incised, and great quantities of fluid, membranes, and pus were let out; irrigation of the pleura caused coughing and choking and a taste of the lotion in his mouth. Syphon-drainage was employed; in three months the lung had expanded, and only a fistula remained, which closed four months later.

Disasters of this kind are not very uncommon, according to Thomas,[1] in cases where a living hydatid of the lung has been treated by puncture. It is not impossible that some of them may be instances of serous œdema of the lung, with profuse albuminous expectoration, such as may follow (Chap. xiv.) the withdrawal of a pleural effusion; but in the cases that I have quoted it is evident that what happened was not this, but escape of the hydatid fluid into the air-passages. As Dr. Bristowe

[1] "Australian Medical Journal," 1889.

has shown, the living hydatid just fills the cavity in the lung, and the walls of this cavity are like a sieve. So soon as the hydatid is punctured or ruptured, air passes from the lung into the cavity, and hydatid fluid passes from the cavity into the lung.

The fear of this is not the only fault of the treatment by puncture or aspiration.

'I have knowledge of at least two cases, in which death very speedily followed simple puncture and aspiration of hydatid cyst, apparently from shock. The result in almost every instance is a failure. The cannula becomes choked immediately by part of the mother-sac, or the numerous daughter-cysts, and hardly more than a few drachms of fluid are withdrawn. The trochar probably enters a daughter-cyst, and this, having emptied itself, forthwith collapses and envelops the cannula; a fresh puncture has to be made, and the same result ensues. Blood may be caused to exude into the sac, and thus considerable harm may follow.'[1]

'Apart from the immediate dangers of puncturing the cyst, there is yet another drawback to this method of treatment. Once you have emptied it, its walls collapse, and you will have a difficulty in finding your way into it if operation becomes necessary.'[2]

And there is also the risk of hydatid fluid leaking into the pleura, and setting up violent inflammation of it. The treatment of hydatid disease of the lung is the same as that of other collections of fluid in it. Exploratory puncture, with a very fine needle, must, if it give sure evidence of the disease, be followed at once by an operation on the same lines as the operation for any other cavity in the lung.

Aspergillus.

The lungs may be infected by vegetable parasites, as well as by those that belong to the animal kingdom.

[1] Sir Dyce Duckworth, "St. Bart. Hosp. Rep.," 1879, vol. xv., p. 28.

[2] Heydenreich, "Semaine Méd.," 1891.

Freyhau[1] has recorded a case of this sort of 'pneumomycosis' in a man, aged 22. He was at first thought to be suffering from pneumonia due to embolism. There was pleural effusion, of a hæmorrhagic character; a fortnight later, he began to expectorate clumps of a mycotic growth—mycelium with conidia—and this continued for many weeks; the opposite lung also became infected. Freyhau points out that this form of infection can only occur in a lung that is weakened by some past disease, *e.g.*, by an old hæmorrhage into its substance. It was noted that the masses of the fungoid growth had the smell of fresh yeast.

Dr. Wheaton has published a case of a child, only 2½ years old, who died of phthisis: not only the lung but the bronchi and the tongue were invaded with patches and masses of aspergillus.

A full account of the presence of these vegetable moulds in the air-sacs of birds is given by Mr. Bland Sutton, in the "Trans. of the Path. Society" for 1885.

Dr. Percy Kidd has shown that injection of the spores of aspergillus into the auricular vein of a rabbit produces an abundant growth of mycelium in various organs, especially in the kidneys ("Path. Soc. Trans.," 1886).

Prof. Boyce[2] has described and figured a specimen of this disease. The apex of the lung showed a few small irregular cavities, in which were scattered white bodies, about the size of pins' heads: these had been mistaken for points of calcification. The history of the specimen was imperfect; the patient had died of heart disease; no marked lung troubles had been noted. 'The fungus is

[1] "Wien. Med. Presse," 1892, p. 185.

[2] Remarks upon a Case of Aspergillar Pneumomycosis, "Journ. Path. Bact.," Oct. 1892. For Dr. Wheaton's case, see "Path. Soc. Trans.," 1890. Virchow first noted the disease in 1856.

usually regarded as a secondary phenomenon, complicating an ulcerated or gangrenous condition of the lung; and undoubtedly the aspergilli, in man at least, are not severely pathogenic. I know of no case occurring of general infection in man.'

In 1876, Fürbringer[1] put together eleven instances where mycotic elements were present in the lung-tissue; in most of the cases they were not observed in the sputa, but were only found *post mortem*. He points out that their growth is always secondary to some grave disease of the lung: nearly always (nine times out of eleven) to the breaking-down of a hæmorrhagic infarct or of an old hæmorrhage in the lung-tissue. It is stagnant disintegrated blood that suits these fungoid moulds. They are not found in acute pulmonary diseases, nor in ordinary acute gangrene of the lung; the latter condition is the work of the organisms of putrefaction, but is not favourable to mycotic growth. There is no evidence that their presence is in itself dangerous to life.

Actinomycosis.

Actinomycosis is a far more important infection, and must be very carefully considered. We are not here concerned with the life-history of the fungus, or with the microscopic characters of its different forms, but only with the clinical signs of its presence in the lungs or the pleuræ. The story of the discovery of the disease is of very great interest. Langenbeck in 1845, Mr. Thomas Smith[2] in 1855, and Lebert in 1857, found

[1] 'Beobachtungen über Lungenmycose beim Menschen,' "Virchow's Arch.," 1876, p. 330. A specimen of the growth has just lately (May 5, 1896) been shown at the Pathological Society.

[2] 'A Fading Record: Early Observations on the Ray-Fungus, by Mr. Thomas Smith.' Dr. Kanthack, "St. Bart. Hosp. Journal," Jan. 1896.

the ray-fungus, and most carefully noted and drew it, but could not explain the nature of it. Böllinger, in 1877, recognized it in the tissues of animals, in the swellings of the tongues and jaw-bones of cattle; the disease, "wooden tongue," had long been known to veterinary surgeons. In 1882, Johne succeeded in inoculating animals with the fungus, and in 1885 Israel inoculated a rabbit from a case of the disease in man; a year later Boström reported that he had succeeded in making cultures of it. The first case in England of actinomycosis of the liver was published in 1885. The first case of the disease in the lung, diagnosed during the patient's life, was communicated to the Medico-Chirurgical Society on Feb. 12th, 1889, by Dr. Douglas Powell and Mr. Godlee—a landmark in the advance of our art.

Israel[1] (1877) collected 38 cases, and divided them according to the way in which infection took place. In 17, the mouth or the pharynx was attacked; in 9, the air-passages or the lungs; and in 7, some part of the alimentary system. In 5, the way of infection was not clearly made out.

The way by which the fungus reaches the lung or the pleura may in this or that case be hard to trace. Israel believed that he found the ray-fungus in the cavity of a decayed tooth, and he has recorded a case where actinomycosis of the lung followed the slipping of a bit of tooth into the air-passages. Partsch[2] has described and figured the root of a bicuspid tooth, from a patient who

---

[1] For the whole subject, see Mr. Shattock's paper in the "Path. Soc. Trans.," 1885.

[2] Partsch, "Die Eingangspforte des Aktinomyces," "Wien. Med. Wchnschr.," 1893, p. 97; Delépine, "Trans. Path. Soc.," 1889. See also "Lancet," Nov. 30th, 1889.

had actinomycosis of the lower jaw, showing two ray-fungi lying just inside the lower end of the pulp-cavity. But Delépine has several times found an organism in the tartar encrusting the teeth, and in the crypts of the tonsils, closely resembling the ray-fungus, but only the common *leptothrix buccalis*, held together by calcareous salts. 'Lately one of my own friends brought me a specimen of this organism, removed from his own mouth—a thing which naturally filled him with anything but pleasant feelings, for he knew all about the parasite—I was, however, able to comfort him very rapidly.' A curious case of infection occurred some few years ago, in an inspector of imported cattle. He had sometimes to look through hundreds of papers relating to their consignment, and used to turn over the sheets moistening his finger on his tongue. Some of the cattle being infected, his lower jaw was attacked by the disease. It is possible that actinomycosis, like aspergillus, can flourish only in a lung that is weak or predisposed to infection.

The fungus, having reached the lung, tends to make its way toward the surface of it, and to infect the pleural cavity. The case may thus present itself to the surgeon as a case of empyema. Or the case during life, or the specimen after death, may be mistaken either for tubercular disease or for sarcoma. Careful examination of the sputa may give positive results. Heusser of Davos,[1] in a female patient sent out there as a case of phthisis, found in the sputa no tubercle-bacilli, but well-marked granules of actinomycosis. The illness ran just the same course as tubercular phthisis with formation of cavities, and she showed marked improvement during her stay at Davos.

[1] "München. Med. Wchnschr.," 1895, p. 49.

There is some reason to believe that actinomycosis of the lung is not necessarily fatal. Schlange[1] gives three cases where he was able to speak with some certainty on this point. 'In one of them, a boy 13 years old, the disease led to multiple perforations of the right side of the chest, so that the case seems hopeless. The other two, who have suffered for five or six years with actinomycosis of the lung, have now for some time had no granules in their sputa, and their general condition is decidedly improved.'

We cannot expect much good from drugs, but iodide of potassium is said to be of some use; and Dr. Poore[2] has just published a case of actinomycosis of the right pleura, drawing attention to Raullin's observation that aspergillus niger—the fungus that one sometimes finds in the auditory meatus—will not grow in a nutrient fluid containing even the faintest trace, one part in a million and a half, of silver nitrate, and will not grow in a silver bowl. He suggests, therefore, that the use of silver nitrate, both as a lotion and internally, may avail to check the growth of the fungus of actinomycosis.

Richerolle (1892) gives the following collection of cases: a careful study of them will show the different conditions of the disease which go in favour of operation or against it.[3]

1. A farm-labourer, aged 29, after a year's illness (slight jaundice, pains over lower right ribs, cough, no hæmoptysis, latterly swelling at the seat of the pains), was admitted to Hospital. There was retraction of the right side of the chest; dulness up to the fifth rib, with loss of breath-sounds

[1] "Zur Prognose der Aktinomycose," "Deutsch. Ges. f. Chir.," 1892.

[2] "Clinical Journal," April 22nd, 1896.

[3] An interesting case of actinomycosis of the wall of the chest has lately been published by Sir Dyce Duckworth ("St. Bart. Hosp. Reports," 1895).

and of vocal vibrations; no râles; no fever; induration of tissues between nipple-line and anterior axillary line. The diagnosis was caries of the ribs with secondary pleurisy. Puncture let out more than a pint of greenish fluid. The swelling increased, the indurated tissues broke down with numerous small fistulæ, and blood-stained fluid escaped, with small granules like lycopodium seeds, which the microscope showed to be actinomycotic. The sputa to the naked eye were indistinguishable from those of slight chronic bronchitis, but were shown by the microscope to contain mycelial filaments. The swelling was now freely opened and the diseased skin removed; but abscesses, containing the fungus, came over all parts of the body, and the patient died, exhausted, of failure of the heart, three years after the onset of the disease. The *post mortem* examination showed subcutaneous and intra-muscular actinomycotic abscesses of the head, trunk, and limbs; the disease had also infected the heart and the pericardium, the spine, the jejunum, and the right testicle. Both lungs were affected, the right pleura, and the intercostal muscles. The disease had begun in the lower lobe of the right lung.

2. The details of this case are not given. Both the club-shaped forms and the filaments of the disease were found in the sputa. *Post mortem*, in the base of the right lung, was a huge abscess cavity, the size of an orange, single, circumscribed: the pus in it was found to contain the fungus. The abscess could easily have been reached by operation.

3. A woman, aged 40, employed in a silk-factory, was admitted to Hospital in March, 1888, after several months' illness (cough, hæmoptysis, shivering fits, evening rise of temperature, night-sweats). Over the right apex, the breath-sounds were harsh, and a friction-sound was heard: the heart-beat was in the third space; cough, fever, thirst, diarrhœa. A few days later, pericardial friction-sounds were heard; signs of thrombosis of the deep veins followed, and she died early in April. The *post mortem* examination showed purulent pericarditis, with abscess of the wall of the right ventricle containing actinomycotic granules; infiltration of the border of the left lung with the disease; and a small mass of it in the right pleura, beneath the ninth and tenth ribs.

4. A boy, 14 years old, was admitted to Hospital in March, 1885, after a year's illness (shiverings, loss of flesh, hæmoptysis, swelling over the right side of the chest, high up and far back toward the spine). On admission, he was

anæmic, dusky, short of breath. In the right interscapular region was a hard dense swelling, without fluctuation. There was a smaller swelling lower down, on the opposite side of the chest, near the spine. Total absence of sounds over the whole of the right lung; slight cough, with catarrhal sputa; liver below ribs, spleen enlarged, œdema over malleoli, much albumen in urine, temp. 100·4°. Exploratory puncture drew only blood. The sputa were very carefully examined, but showed neither tubercle bacilli nor actinomycotic forms. He died a month after admission. *Post mortem*, sero-purulent effusion in the peritoneal cavity. The right lung was everywhere adherent. The disease was diffused throughout the right pleura, and had invaded the posterior mediastinum, the diaphragm, and the front of the spine. The left lung, not adherent, showed false membranes, and soft, reddish-gray granulations, over its lower lobe.

5. A woman, 50 years old, suffering with cough, noted a painful purplish swelling to the inner side of the right breast. Later, it fluctuated, broke down at several points, and discharged a large quantity of pus. Actinomycotic forms were found both in the discharge and in the sputa. The breast was removed, but this did not stop the advance of the disease. The *post mortem* examination showed that it had begun in the right lung, and spread thence into the anterior mediastinum and the breast.

One only of these five cases was likely to receive much benefit from surgery. Still, the disease sometimes presents signs less unfavourable for surgical interference. It may be not diffuse and multiple, but single and circumscribed. The surgeon may, under these circumstances, save life, or may at least prolong it, and improve the general condition of the patient.

CHAPTER XXVII.

SUBPHRENIC ABSCESS. OPERATION THROUGH THE PLEURA FOR HYDATID CYST OF THE LIVER.

WE have in this last chapter to note two diseases that begin outside the chest, but may, as they advance, infect or invade it: suppuration starting beneath the diaphragm and subsequently invading the pleura, and hydatid cyst of the liver pushing upward into the chest. Of both these disorders many cases have of late years been recorded, which are full of interest.

SUBPHRENIC ABSCESS.

The history of the exact diagnosis and treatment of this disease begins with a case published in 1845[1] by Dr. Barlow and Dr. Wilks: it was an example of subphrenic abscess of the left side, containing gas as well as pus, due to perforation of the stomach. It had caused inflammation of the left pleura, with sero-purulent effusion, but there was no actual perforation of the diaphragm. The physical signs closely imitated those of pyo-pneumothorax; but careful examination showed that the collection of gas lay *below* the level of the pleural effusion. There was no history of any disease of the lungs such as would be likely to cause pyo-pneumothorax; it was hard to see how there could be two distinct effusions in the pleura, one above, of fluid only, and one below, of fluid and gas together; and the site of the

[1] "London Medical Gazette," May, 1845.

most marked resonance was beneath the false ribs. For these reasons, the case was rightly diagnosed as one of subphrenic abscess.[1] From about this time onward, many isolated examples of the disease were published; and monographs on it were written by Leyden (1880) and Tillmann (1882). In England, beside a number of records of separate cases, we have the very valuable work of Dr. Penrose and Dr. Lee Dickinson[2] (1893), Dr. Coupland, Dr. Hector Mackenzie, and Mr. Gilbert Barling[3]; and in 1894, Maydl's book[4] was published, which swept into its net every case that had hitherto been recorded.

Maydl, dealing with a collection of no less than 179 cases, divides them according to their causes. The stomach or the duodenum started the suppuration in 35 cases; the cæcum or the appendix, in 25; the liver or the biliary passages, in 20; internal injuries, in 18; hydatid disease, in 17; the intestines, in 13. There were 11 cases of 'metastatic' subphrenic abscess: 11 followed inflammation round the kidney; and 11 were 'miscellaneous.' Disease inside the chest was the cause of

[1] 'Our admiration at the acuteness of this diagnosis must be mixed with some astonishment that even now, forty years later—in spite of the warning given by this case not to confound a pyo-pneumothorax with a subphrenic abscess containing air—some of the signs of the latter disease, as Barlow described them, are either neglected, or not formulated so sharply and accurately as they were by him. His short and pregnant notes on the case contain all that is essential in the whole series of accepted modern views as to the causes and diagnosis of subphrenic abscess.' Maydl, p. 7.

[2] "Cases of Abscess beneath the Diaphragm in connection with Perforating Gastric Ulcer." "Clin. Soc. Trans.," 1893, vol. xxvi., p. 72.

[3] "Gastric Perforation," etc., "Ingleby Lectures," 1895.

[4] "Ueber Subphrenische Abscesse." Wien, 1894, 357 pages. Since Maydl's book, there is an excellent essay, with many diagrams, by Sachs, "Arch. f. Klin. Chir.," 1895, vol. l., p. 16.

subphrenic abscess in 9 cases; external injuries in 6; and caries of the ribs in 3.

To the question, how often these subphrenic abscesses contain air or gas as well as pus, he replies that it depends chiefly on the primary cause of the abscess.

Starting-Point of the Abscess.	Total Number of Cases.	Number of Cases where Air or Gas was in the Abscess cavity.
Stomach or Duodenum	35	20
Cæcum or Appendix	25	8
Liver or Biliary Passages	20	1
Internal Injuries	18	3
Hydatid Disease	17	3
Intestines	13	4
'Metastatic'	11	1
Perinephritis	11	1
'Miscellaneous'	11	5
Disease inside the Chest	9	1
External Injuries	6	0
Caries of the Ribs	3	0

To indicate the difference in physical signs between a pyo-pneumothorax and a subphrenic abscess containing gas, he gives two diagrams (*Plate* XII.); and a good commentary on them is to be found in what Dr. Coupland and Mr. Barling have lately written about the diagnosis of these cases. In addition to the general signs of pus-formation, local signs present themselves: a swelling, or at all events a fulness, in the epigastrium. The physical signs are those of pneumothorax, but they are in a different position from that which pneumothorax occupies. There is hyper-resonance at the upper part of the abdomen, extending somewhat up to the thorax; but not to its summit, where the physical signs may be normal. The tympanitic resonance may extend upward behind the sternum to a remarkable degree, perhaps into the axilla and posteriorly also. With this resonance there may be amphoric breathing, and a bell-sound may be obtainable. The heart undergoes displacement to some extent,

PLATE XII.

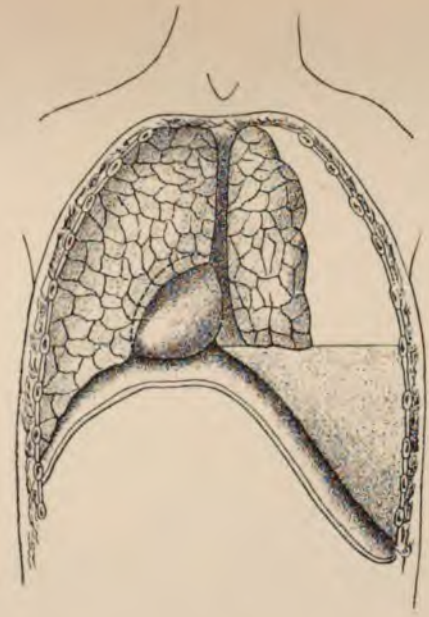


Fig. A.—Diagram to show the character of the physical signs in pyo-pneumothorax. (From Maydl, Ueber Subphrenische Abscesse, 1894.)

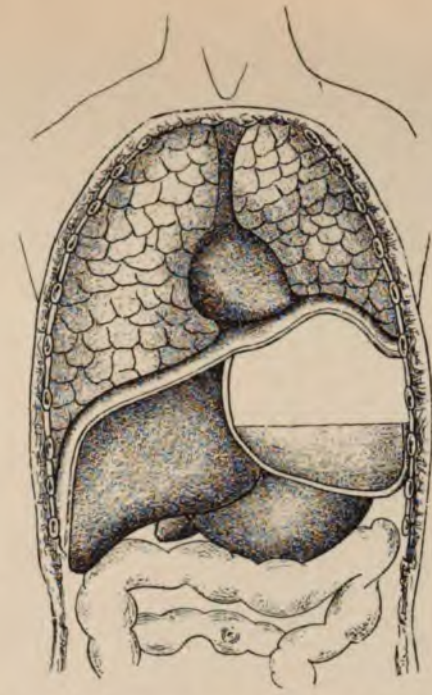


Fig. B.—Diagram to show the character of the physical signs of a subphrenic abscess with gas in it. (From Maydl.)

[Face p. 424

but not to the degree that it does in pneumothorax. With this tympanitic resonance in front, evidence arises of pleurisy or of lung consolidation.[1]

It is important to bear in mind the extraordinary number of different causes that may lead to subphrenic abscess. Lampe[2] last year published seven cases: two from gastric ulcer, two from ulceration or gangrene of the vermiform appendix, one from internal injury, one after curetting of the uterus, and one from empyema.

With so many possible causes, subphrenic abscess can hardly be a rare disease; and Dr. Penrose and Dr. Lee Dickinson found that ten cases (all from gastric ulcer)

---

[1] Dr. Sidney Coupland, "Subphrenic Abscess simulating Pneumothorax." "Brit. Med. Journ.," March 23rd, 1889.

[2] "München. Med. Wchnschr.," May 14th, 1895. An abstract of the cases is given in the "Brit. Med. Journ.," July 6th, 1895. (1) A man, 2[illegible] years old: rupture of gastric ulcer on posterior wall of stomach, near pylorus; suppurative peritonitis; operation; death. (2) A man, 25 years old: gastric ulcer near greater curvature: pain in the epigastrium and vomiting, four and a half weeks previously; operation; death. (3) A man, 38 years old: had long suffered from constipation; illness began with abdominal pain and fever; later, jaundice, and pain in region of liver. Was already dying when admitted to Hospital; no operation. *Post mortem*, gangrene of vermiform appendix. The inflammation had extended upward behind the cæcum, kidney, and liver, to the subphrenic region on the right side. (4) A boy, aged 14: perforation of appendix, perityphlitic abscess, suppurative phlebitis, hepatic abscess; operation; death. (5) A man, aged 30: the disease followed a blow; operation; after a very severe illness, was on the way to recovery at the time his case was published. (6) A woman, aged 3[illegible]: curetting of the uterus on the second day of an incomplete abortion; pain in upper part of abdomen began on seventh day; operation; recovery. (7) A man, 22 years old: after pneumonia, empyema, which opened into the air-passages. For a time, he improved; then came pain in the lower part of the chest, and in the abdomen. Operation showed a perforation of the diaphragm; recovery. Thus, of the 7 cases, 3 recovered after operation, 3 died after it, and 1 died without it. In none of them was there gas in the abscess-cavity. In three of them, there was a serous effusion in the pleura.

were recorded at St. George's Hospital in little more than four years (Dec. 1887 to March, 1892).

It is strange that so many cases of subphrenic abscess should be due to disease of the vermiform appendix. According as the suppuration round the appendix is inside or outside the peritoneal cavity, so its extension upward to the subphrenic region is intra- or extra-peritoneal.[1] Out of Maydl's 25 cases, 11 were left without operation: 9 died and 2 recovered. Of the 14 who received operation, no less than 9 were saved. In one or two of the cases the cæcum was at fault (ulceration, perforation with fish-bone) not the appendix. The time that elapsed between the onset of the perityphlitis and the plain signs of subphrenic abscess, was in one case only three days; in five, it was less than three weeks; in five, between three and six weeks; in one, eight weeks. Careful analysis of the 25 cases shows that in every case left without operation, the diaphragm sooner or later was perforated; but of the 14 who had an operation, perforation was found in 2 only; and in several, the signs of a pleural effusion, well marked before the operation, disappeared after it.

The following case, from Hofmokl, is a good picture of this form of subphrenic abscess:—

A boy, 16 years old, was attacked on Sept. 25th with acute perityphlitis (fever, shivering, vomiting, swelling in right iliac fossa). Sept. 30th, pain and fulness in the right hy ochondrium; physical signs of displacement

[1] The question arises, why perityphlitic abscesses should run *upward*, while the ordinary psoas abscesses of spinal caries run *downward*. Maydl answers that the patients with spinal caries are allowed to be up and about, so that their abscesses gravitate downward; the patients with perityphlitic abscesses are kept in bed; it is easy for their abscesses to run upward behind the ascending colon and the right kidney, and thus to reach the subphrenic region.

upward of the diaphragm. For the next nine days, nothing was done; no change for the worse; less pain. Oct. 9th, increased difficulty of breathing, and oppression. That evening he suddenly collapsed; and now, for the first time, signs were found of fluid in the lower part of the right pleura, and auscultation gave high-pitched metallic tinkling sounds and well marked Hippocratic splash. Next day, the fluid in the pleura was increased, and the heart was displaced toward the left. Two days later (Oct. 12th) resection was made of the seventh rib, outside the nipple, and gas and fœtid pus escaped. The diaphragm was felt to be pushed upward, and very tense, moving only a little in respiration. It was explored with a needle, and similar pus was drawn off. It was incised, the opening dilated, and nearly a quart of fœtid pus let out. Two thick tubes; irrigation. He did well at first; but the lung failed to expand, and he died exhausted at the end of the month. No *post mortem* examination was allowed.

The prognosis of subphrenic abscess, as a whole, is very clearly brought out by Maydl's work. Left to itself, it is almost necessarily fatal. Out of 104 cases where no operation was performed, only 6 recovered, by the breaking of the pus into the lung or into the bowel.[1] Of the 98 that died, 77 had no surgical treatment of any

[1] Dr. Myrtle ("Clin. Soc. Trans.," 1890, vol. xxiii., p. 154) records a case where an abscess, after nephrectomy, left without operation, finally burst into the lung, and the patient recovered; but for nearly three months she had gone through very severe suffering.

Mr. Wheelhouse ("Brit. Med. Journ.," 1889, vol. ii.) has recorded two cases of subphrenic abscess which finally burst into the bowel, and the patients recovered. Hofmokl has recorded a case where the disease burst into the lung; the patient died. In two of these three cases, the pleura had already been incised, and pus let out.

kind, 5 were punctured but nothing was found, and 16 were punctured and the abscess was found, but the surgeon did not go on to incise it. Out of these 98 fatal cases, the abscess burst before death into the lungs or the bowel in 19; but 79 patients died unrelieved either by Nature or by art.

Out of 74 cases treated by incision, with or without resection, 35 died and 39 were saved. But these 35 deaths want some explanation. In one case, and in one only, was the operation itself the cause of death. In five, the surgeon opened an abscess communicating with the subphrenic abscess, but left the subphrenic abscess undrained. In seven, he opened the subphrenic abscess, but left an empyema undrained. In nine, the operation failed because there was suppuration in some other more or less remote region of the body. In four, there was purulent peritonitis. And in all the rest there were special conditions opposing themselves to the success of the operation—pneumonia, tuberculous disease of the kidneys, pyæmia. One patient died suddenly of syncope during irrigation; in another, pleural adhesions were present at the time of operation, but broke down after it, and the patient died of septic pleurisy; in another, the subphrenic abscess was opened, but incision of a large empyema was put off for a day or two, as the patient was very feeble; and the delay proved fatal.

To attempt to cure subphrenic abscess by aspiration is almost or quite hopeless. Eight patients thus treated all died: one of them two hours after aspiration, and one a few minutes after it. There seems to be a special risk of syncope in aspirating a subphrenic abscess; and in addition to this, there are all the same difficulties and drawbacks that attend aspiration of an empyema. There is, so far as I know, not a single record of recovery from

subphrenic abscess after aspiration.[1] The whole treatment of subphrenic abscess has gone side by side with the treatment of empyema: the same practice of puncture and aspiration, the same fear of incision, the same attempt to use syphon-drainage, and the same period of inaction (1850-1870) before the New Age. Since, therefore, incision is the only proper treatment of subphrenic abscess, we have to ask what are the chances that we shall have to open the pleura, and by what method we shall operate.

Taking Maydl's 74 cases treated by incision, with or without resection, we find that in 40 of them the operation was done through the chest-wall. In 34, the abscess was reached by incision elsewhere, *e.g.*, through the epigastrium, the hypochondrium, the iliac region or the loin. With the fortunes of these 34 cases we are not here concerned, as they do not belong to the surgery of the chest. We must, however, note the great difficulty in subphrenic abscess, from perforated gastric ulcer, that comes from the burrowing backward and downward of the pus toward the spleen; the danger of pericarditis; and the simulation of the friction-sound of pericarditis caused by the deposit of lymph on the outer surface of the pericardium, as happened in two of the ten cases collected by Dr. Penrose and Dr. Lee Dickinson. We have also to remember that in no less than 9 out of these 34 cases, the surgeon reached and drained the subphrenic abscess without going through the chest-wall, but left untouched

[1] 'Beside other dangers of aspiration, the contents of a subphrenic abscess are by no means always of a kind to come through an aspirating-needle. Thick like pea-soup, or frothy like yeast, or mixed with gangrenous shreds of tissue, hydatid membranes, fragments of undigested food, or bits of fæces, the pus is often utterly unable to do anything of the kind. There may be a foreign body in the cavity; or it may communicate with the alimentary canal, the gall-bladder, the bile ducts, or a cavity in the lung.' Maydl, *loc. cit.* p. 341.

an empyema; and in 1 case, he drained the subphrenic abscess, and would have incised the empyema also, but the patient was so feeble that he put it off for a day or two. All these 10 patients died.

In the 40 cases where the operation was done through the chest-wall, in 18 of them the pleura was found shut off by adhesions; in 10 there were no adhesions, and no effusion; in 5 there was a serous effusion; in the remaining 7 there was a purulent effusion.

In some of the cases, the incision through the chest-wall was the only one made, and the diaphragm was incised through it, or had already given way. In others, aspiration or incision had already been practised in some other region of the body.

A good case of direct incision of the chest-wall was reported by Dr. Hector Mackenzie and Mr. Abbott at the Clinical Society last year. The patient was a boy 10 years old. The abscess, probably due to ruptured gastric or duodenal ulcer, had already broken into the pleura; there was a rounded, red, acutely tender swelling in the epigastrium, which became more prominent and fluctuating when he sat up or coughed; and there were signs of pyo-pneumothorax of the right side. 'From the physical signs, it was evident that the communication between the subphrenic abscess and the empyema was a very free one, and it was therefore decided to drain both through an opening in the pleura.' Resection of sixth rib just behind axillary line; a pint and a half of thin fœtid pus was let out; the lung at once expanded well. The upper surface of the liver was felt through an opening in the diaphragm extending from about the tip of the ninth costal cartilage nearly to the middle line. The exact limits of the subphrenic cavity were not made out. The cavity was well washed out,

and a double tube inserted into the pleura : daily irrigation ; wound healed in about five weeks ; complete recovery, with perfect expansion of lung.[1]

As instances of incision of the chest-wall, subsequent to aspiration or incision of the abscess outside the chest, we may take the following cases :—A boy, 15 years old, was attacked with acute peritonitis, ending in an abscess in the lower part of the abdomen : this was aspirated, and thin fœtid pus was drawn off. About three weeks later, there was swelling just above the liver, giving a tympanitic note on percussion. The diaphragm was pushed upward ; there was well-marked friction-sound at the lower border of the lung, and Hippocratic splash. Some abdominal distension ; severe cough ; marked loss of strength. Resection was made of the ninth rib ; nearly a pint of fœtid pus was let out ; the lung gradually expanded. No fluctuation was felt beneath the diaphragm. The boy died ten days later, with signs of peritonitis. The *post mortem* examination showed diffuse peritonitis, with adhesions and pockets of pus ; liver adherent to diaphragm, except at one place, where there was a circumscribed abscess. The communication between this and the pleura could not be made out. In another case, a perityphlitic abscess was opened (September 25th) by an incision in the loin, with resection of the twelfth rib. On October 13th, this incision was enlarged, and a fæcal concretion was found in the abscess-cavity. On October 25th, the patient was found to have empyema of the right side ; the usual operation was done for its relief, and he got well. In another, a subphrenic abscess, due to a small hydatid cyst, and containing gas as well as

[1] "The surgical treatment in this case was merely that of an ordinary empyema, and the sub-diaphragmatic abscess drained excellently by this route, better than it could possibly have done through an incision immediately over it."

pus, was treated by exploratory puncture; and this was followed by high fever. A piece of the seventh rib was therefore resected in the nipple line, and the abscess was freely incised: the pleura was not opened. A counter-opening was made below the ribs. The patient did well for a month, then got influenza, and was found to have empyema of the right side. This was treated by the usual operation, but he died of pneumonia and exhaustion 12 days later.

Of subphrenic abscess *secondary to acute inflammation within the chest*, Maydl has collected 9 instances. The primary diseases were as follows:—in 3 cases, gangrene of the lung; in 2, empyema; in 2, pleuro-pneumonia; in 1, gangrenous empyema; in 1, abscess of the lung. One case, in which the diagnosis was not absolutely certain, recovered without operation; one recovered after operation; the rest died, either without any operation, or after simple puncture without incision.

Eight of the cases I put in the note here.[1] They show

[1] 1. A man, 31 years old, was admitted to Hospital on June 20th, 1869. There was dulness of the right side up to the nipple-line, and the liver came well below the ribs. The diagnosis was 'hyperæmia of the liver.' August 1st—3rd, pains in epigastrium and right side, feeling of suffocation, impeded movement of right side, nothing found amiss in heart or lungs. The diagnosis was changed to 'diaphragmatic pleurisy.' August 7th, dulness and loss of breath-sounds up to angle of scapula, redness and œdema of skin of right hypochondrium. The diagnosis was again changed to 'pyo-pneumothorax, probably due to abscess of the liver.' August 9th, general condition worse; swelling, tenderness, and emphysema of skin above nipple; puncture in the third space let out fœtid gas. Two days later, turbid fœtid fluid began to ooze through the punctures. Three days later he died. *Post mortem*, gangrenous empyema, gangrenous softening and perforation of the diaphragm, leading into a fœtid subphrenic abscess.

2. A man, aged 21, after pneumonia, had empyema of the right side. This was treated by incision with resection. A few days later, during irrigation of the cavity, he suddenly died. *Post mortem*, serous pericarditis, three and a half pints of pus in

clearly how hard may be the diagnosis of acute inflam-

the right pleura, and a small perforation of the diaphragm, leading into a cavity to the left of the suspensory ligament.

3. A man suffering urgent dyspnœa was admitted to Hospital, and died soon after puncture of the chest. *Post mortem*, more than five pints of pus in the right pleura, perforation of diaphragm, subphrenic abscess, pericardial adhesions.

4. A man, aged 48, was admitted to Hospital on March 23rd, suffering colic and pains in the stomach. His illness began nine days ago, with intense abdominal pain; he vomited twice the first day, but not since. Next day there was tenderness of the abdomen, with pain in the left hypochondrium, shooting up to the left shoulder; liver two fingers breadth below ribs, prolonged expiration below both clavicles, with mucous râles. The first diagnosis, 'tubercular phthisis in its earliest stage' was now changed to 'abscess within the chest.' A week later, he coughed up four or five ounces of pus and blood together, and this was followed by intense abdominal pain and oppression, slight dulness over both bases. The diagnosis was now again changed to 'abscess either in the liver or in the pleura.' On April 12th he died. *Post mortem*, gangrene of the whole under aspect of the lower lobe of the left lung, perforation of the diaphragm, subphrenic abscess.

5. A man, aged 19, was in Hospital supposed to be suffering from tubercular disease of both apices, serous pericarditis, and right pleural effusion. *Post mortem*, sero-purulent pericardial effusion, with fibrinous deposit. At the base of the right lung, diffuse purulent infiltration, and in one place a circumscribed abscess. Multiple perforations of the diaphragm, and subphrenic abscess.

6. A woman, aged 40, insane, was supposed to be suffering from slow tubercular disease of the right lung *Post mortem*, gangrene of the lower lobe of the right lung, and of the diaphragm beneath it, and subphrenic abscess. Double sero-fibrinous pleural effusion, fibrinous pericarditis.

7. A woman, aged 58, *post mortem* record only. Gangrenous exudation over lower part of right pleura and lung. On the under aspect of the lower lobe, an opening in the lung, leading into a gangrenous cavity in it. The diaphragm was perforated in many places, and there was a gangrenous abscess in the liver.

8. A man, aged 27, was admitted to Hospital with double pleuro-pneumonia, and diaphragmatic pleurisy. Ten days later, there was increased pain in the right hypochondrium, and a rounded tense fluctuating swelling could be made out here. The liver dulness extended upward to the nipple, and downward four fingers' breadth below the ribs; the veins over the swelling were enlarged. A fortnight later, the swelling could no longer be felt to fluctuate, and a fortnight later it was gone. He made a complete recovery.

mation inside the chest ending in perforation of the diaphragm, and how useless it is to attempt to cure these cases by puncture. The ninth and most important case was published by Meltzer in 1893:—

A child, between 2 and 3 years old, after two attacks of acute pneumonia, was again taken ill with high fever, sweats, acute swelling of the spleen; the liver was felt below the ribs, and there was pain in the right hypochondrium, with dulness over the right base behind, and loss of breath-sounds and of vocal vibration. On the 6th day, 42 days after the first attack of pneumonia, an exploratory puncture was made, and pus was drawn off. The diagnosis of empyema thus seemed absolutely certain. Next day, an inch-and-a-half of the eight rib were resected, about the posterior axillary line; a second puncture was now made, and pus was again found. The pleura was incised, but only about half a teaspoonful of pus came out. 'My wound was large enough for me to see how the diaphragm, fixed and tense, was pushed upward into the chest. The lung was not wholly collapsed; I felt its lower edge, which was somewhat thickened. There were neither adhesions, nor a circumscribed empyema, but I could feel distinct fluctuation all over the diaphragm; in a word, I had to do with a subphrenic abscess. On close examination, I observed a pin-point opening in the diaphragm, whence had come the few drops of pus in the pleura. I dilated it, fitted a big tube into it, and by gentle pressure on the diaphragm got out the pus without soiling the pleura. Then I explored the cavity with my finger; several empty pockets opened into it. The upper surface of the liver was perfectly smooth.' The temperature ran high for several days, but was brought down with quinine. The tube was removed at the end of three weeks. Complete recovery.

It is evident that the operation for subphrenic abscess has no fixed method for every case. We must be guided by the history of the patient, the situation of the primary disease, the physical signs, and the evidence of exploratory puncture. One thing is certain, that the patient must not be left without operation, and that any treatment short of incision and thorough drainage is useless.

Operation through the Pleura for Hydatid Cyst of the Liver.

It is plain that a hydatid cyst of the upper surface of the liver, kidney, or spleen, growing upward beneath the ribs, may be accessible to free incision only by an operation through the chest-wall: it is indeed a huge subphrenic cyst or abscess. To Maydl's collection of 17 cases of this kind, several others may now be added, published by Mr. Tyson, Dr. Rudall, and others; and two which I published last year.[1] The difficulties of diagnosis, in these cases where the disease does not come forward beneath the ribs, are very great: the diagnosis usually made is 'hepatitis' or 'hepatic colic,' or 'pleurisy with effusion.' The very slow growth of the cyst, the irregularity and intermittence of the symptoms due to it, the absence of any visible or tangible swelling below the ribs—all these make early diagnosis almost impossible, especially as one's thoughts are not at all likely to be set in the direction of hydatid disease. Thus these cases of what we may call 'hidden hydatid' are full of clinical interest; and the list of wrong diagnoses is of considerable length. It is indeed more important to study their history before operation than to note the technique of the operation itself; for the rules for the thoracic operation for hydatid of the liver are the same as those for subphrenic abscess or for abscess of the liver, when these have to be attacked through the chest-wall: careful exploratory puncture, occlusion of the general cavity of the pleura, free incision of the cyst, and free drainage. A very large drain is needed; the rubber tube sold for gas-piping is more to the purpose than ordinary surgical drainage-tube.

[1] See "Clin. Soc. Trans.," 1888 and 1894; "British Med. Journal," July 6, and Nov. 2, 1895.

Of Maydl's 17 cases, 9 were female; 6, male; in 2, sex not stated. As to age, 12 were between 20 and 40 years old, and the rest were over 40. We must keep in mind the possibility that a subphrenic hydatid cyst may have its starting-point not in the liver, but in the loose cellular tissue between it and the diaphragm; or in the kidney, or in the spleen.

The continued flow of bile from the operation-wound may severely weaken the patient; but I know of no case where it proved fatal. Maydl says of it: 'This flow of bile may come on some time after the operation, when the cyst-wall begins to come away. Often it lasts for weeks, and only subsides when it has brought the patient to the brink of the grave. Out of my 17 cases, 5 suffered from it; but in none did it prevent final complete recovery, though some had come very low by the time it ceased: nor do we clearly know what made it cease. In one case, to stop it, two ribs were resected, and this procedure appeared to be successful. The resection either helped the cavity to close, or obliterated the open mouth of the sinus through which the bile was flowing.'

My own two cases were as follows:—

1. A man, 28 years old: his troubles began seven years ago, when he was taken ill, somewhat suddenly, with sharp pain and tenderness in the region of the gall-bladder, vomiting, and jaundice, and was laid up for some weeks. The diagnosis on this occasion was 'biliary gravel,' and it was thought that the gall-bladder could be felt enlarged. From this time onward he was subject to similar attacks, which occurred suddenly and at irregular intervals about twice a year. Between them, he was in his usual good health. In some of them, he was not jaundiced; but, with this exception, they were all very much alike: sudden in their onset, slow to pass away, marked by severe pain and tenderness about the region of the gall-bladder; and, in the later attacks, the pain used to shoot round to the back, and up to the right shoulder. In the autumn of 1894 he had an

attack of unusual severity, which lasted many weeks; his pain was aggravated by obstinate constipation, with accumulation of wind in the bowels. On Dec. 13th, 1894, he had, for the first time, a rigor: others occurred on the 21st and 22nd, and on the 24th there were signs, not well marked, of a slight pleural effusion in front, immediately above the liver: about this time also he began to be troubled with sweats, which were at times very profuse. But the signs of effusion passed off, and so did the sweats; and during the greater part of January, and the first half of February, his temperature was about normal, and he seemed once more to be convalescent. But on Feb. 14th he again had a rigor, with temp. 102°, and in March his temperature was hectic, 101° or 102° every night: he was frequently in pain, and was plainly losing ground. His condition just before operation (March 28th) was as follows: Though he did not appear in immediate danger of his life, he was very weak and feverish, restless, and depressed, suffering from severe lancinating pains not only in the region of the liver, the right side, and the right shoulder, but also up the spine to the back of the head, and down the backs of both thighs to the calves. There was no enlargement of the front of the liver, nor could its edge be felt below the ribs, nor was there any increase of the liver dulness in front. Behind, in the line of the angle of the scapula, there was slight dulness over the lower ribs, from the seventh to the tenth, and the intercostal spaces here felt somewhat firmer than natural. And it is worth noting that when this area was percussed, the patient himself felt a distinct thrill or wave in the region of the liver. The significance of these signs, and of the whole history of the case, was pointed out by Dr. Douglas Powell, who kindly saw the patient with me, and made the diagnosis of suppurating hydatid. *Operation*: Exploring syringe put in at ninth right space, just below angle of scapula, and thrust straight forward for 3½ or 4 inches, and pus found. Needle left *in situ* as a guide; resection of 3 inches of ninth rib; the pleura was laid open freely, and air was drawn into it with each inspiration. No pleural adhesions, no fluid in pleura, lung not seen. The diaphragm was very tense, and was pushed up so high that it was almost vertical; it moved hardly at all in respiration. There was a clear space, from ½ to 1 inch, between it and the chest-wall. I fastened the diaphragm to the pleura, putting in two stitches with a strong curved needle on a long handle; the needle was passed first through the diaphragm, taking firm hold on it, then through

the pleura—it was impossible to pass it the reverse way, as the diaphragm kept moving just out of reach. Then I incised the diaphragm, punctured the cyst, dilated the opening, laid the cyst freely open, and fastened it in the wound. About a quart of purulent fluid and cysts were let out. Irrigation; drainage for four weeks; lung quickly expanded; recovery. A very little bile flowed through the wound, but not after the first week or ten days.

2. A man, aged 50, syphilitic, given to drink: arteries rigid, well marked arcus senilis. Two and a-half years ago, he suffered pain in the region of the liver, shooting up to the right shoulder, continuous, not paroxysmal, worse on deep inspiration; had also abdominal pains, and was jaundiced. Was in Hospital five weeks; his board was headed, 'Hepatitis,' and the notes say, 'Pain in the right side, tenderness over the ninth rib, and a doubtful feeling of fulness on the right side.' His temperature was raised to 101° or 102° every night for three weeks. Then the pains and fever ceased, he left the Hospital, and nothing was heard of him for two and a half years. Then he came back, having had a second attack of jaundice, followed by return of his old pains. His condition just before operation was almost hopeless. Apart from his being in every way a bad subject for an operation, he had steadily refused it up to the last moment, and had taken a great change for the worse in the last twenty-four hours. Peritonitis had already set in; his temperature, after standing at 100° to 103° for many days, had suddenly dropped; tongue dry, pulse quick and feeble, breathing shallow and painful, face thin and drawn, jaundice, frequent vomiting, diarrhœa, and utter exhaustion. The liver was 3½ inches below the ribs, and its vertical dulness, in the nipple line, was 6½ inches; but the surface thus exposed did not feel tense, nor did it raise the abdominal wall over it to any marked extent. In the axillary line, dulness began at the lower border of the seventh rib; the breath-sounds at the base of the lung were normal. *Operation*: As the liver reached so far below the ribs in front, I hoped to reach the cyst here, so opened the abdomen through the right rectus muscle. More than half a pint of turbid fluid ran out, with flakes of lymph. The liver appeared smooth, soft, and of natural colour and outline: plainly it was depressed by some growth in the upper posterior part of it. I explored it in two places to a depth of 2 or 2½ inches, but only blood came. I now stopped the oozing from the needle-holes by putting a fine stitch into

them, closed the abdominal wound, made a small incision over the dull area behind, and thrust a syringe well forward through the eighth space in the posterior axillary line, and found pus. I used the needle as a guide, resected the ninth rib, and came straight down on the naked fibres of the diaphragm at their insertion into the tenth rib, and did not open the pleura. Cyst opened and drained. The peritonitis made the operation hopeless from the first, and the patient died the next day. *Post mortem*, a large thick-walled hydatid cyst, 8 or 9 inches in diameter, growing from the upper posterior aspect of the liver. Peritonitis; and about a pint of sero-purulent fluid, with flakes of lymph, in the right pleura. The cyst lay so far back that it would have been impossible to reach it from the front.

These two cases are good instances of the difficulty of diagnosis of a 'hidden hydatid' of the liver. The first had been diagnosed, 7 years ago, as disease of the gall-bladder; the second, 2½ years ago, as 'hepatitis.' In both of them, the disease advanced not regularly but by fits and starts: a short sharp attack of illness was followed by a long period of apparent health. The first patient had many attacks of this character; the second had an interval of 2½ years between two attacks. Again, in the first case, the liver was not below the ribs at all; in the second, it was below the ribs, but not tense or prominent. Under such conditions, diagnosis is well-nigh impossible. What finally led toward a right view of the two cases were the occurrence of fever, rigors, and sweats, the gradual extension of the diffusion of the pain, the gradual increase of pressure upward and backward, and at last the slow deterioration of both patients: in spite of most careful treatment and nursing, they were going from bad to worse, losing flesh and strength, with steady increase of fever and of pain.

Of Maydl's 17 cases, 14 were submitted to operation; 9 with incision and resection; 5 with incision only; in 2 of these 5, there was an abscess pointing under the

skin, which was found to lead by a fistulous track into the cyst. Of these 14, 8 were cured, and 6 died in spite of operation; in 2 of the 6, the cavity was well advanced toward healing; and death was due to phthisis in one case, and influenza in the other.

I have done my best to put clearly the work that is now being done, in England and in other countries, in one field of surgery. The record of the last twenty years is wonderful indeed, and we have gone forward so far and so fast, that what we want now is rather to see more readily and more accurately the indications for operation, than to invent new methods of operating. 'The wheel has come full circle'; the discoveries of Lister have brought us back to the free incision practised by Hippocrates. To Lister's work we might apply Pope's fine saying:—

> "Nature and Nature's works lay hid in night;
> God said, 'Let Newton be,' and all was light:"

and as I have put Paget's name on the first page of this book, so, with the same gratitude for his teaching and for the example of his life, I write Lister's name on the last.

APPENDICES.

APPENDIX A.

M. RÉCLUS' ADDRESS AT THE FRENCH SURGICAL CONGRESS, 1895.

WHEN it was proved by experiment that one could remove the whole, or part of the lung of a rabbit, without seriously injuring it, it seemed certain that the surgery of the lung had a splendid future before it. We were told that its delicate texture, and its relation to the life of the blood, and its nearness to the heart, are no real reasons against operating on it, and that the surgeon has as much right to interfere with the lung as with the limbs or face; and Glück went so far as to quote the old saying, "Ubi hæmorrhagia, ibi ligatura; ubi tumor, ibi extirpatio; ubi pus, ibi incisio." How far shall we accept this threefold assertion? Our answer must rest on the hard facts of experience; and we shall be able to give it now, for we have been interrogating the surgery of the lung for the last twenty years after a truly scientific method, in the strength of the work of the present time.

The New Age began when Neisler, in 1873, opened a cavity in the lung of a phthisical patient, 59 years old; and from that time onward we have records of many operations and of many methods. I had thought to tabulate them all; but Truc gives most of the cases up to 1885; so I advise you to study his excellent book for these earlier records, and I shall tabulate the cases of the last ten years, 1885-1895, and no others. The conditions of the lung that may at the present day call for the help of surgery have a very wide range, but we may divide them with fair accuracy, according to Glück's aphorism. There are the hæmorrhages, either from injury or disease, that may require a ligature; the new growths, represented by tubercular growths and malignant disease, that may need extirpation; finally, there are the cavities—fluid or putrid masses within the lung, phthisical cavities, br nchiectasis, localized gangrene, abscess, hydatid cyst: here the treatment is a more simple affair—incision, not excision.

I.

Seldom indeed have surgeons interfered in hæmorrhage from the lung due to injury: we have no facts to go upon. There are the two cases reported by Omboni and Delorme; shall we be discouraged that they failed? I think not. I believe that in a case of hæmorrhage persisting in spite of rest, immobilization of the chest-wall, and occlusion of the wound, if the loss of blood is endangering the patient's life, is filling the pleura, and threatening to stop the action of the heart, or of the lung, then a free opening into the chest will enable the surgeon to stop the bleeding, by tying the vessel, or the piece of lung which is wounded, or by packing the wound with iodoform gauze. If we wait, the patient may bleed past hope of help: on the other hand, we must not forget that it is a very serious business to interfere in these cases, to inflict the shock of operation on a patient already enfeebled, and to induce pneumothorax of the whole side of the chest, over and above the disadvantages which are already hindering the vital changes in the blood.

And here we may recall Simpson's attempt to establish a surgical treatment of pulmonary apoplexy. In 1890 he published 4 cases of hæmorrhage into the lung-tissue with œdema. The symptoms were of such a character that there was no hope of recovery. The hæmorrhages were treated with aspiration through the fifth space, done under circumstances of the greatest urgency. The quantity of blood withdrawn was in one case 12½ ounces; in another, the œdema was so great that only serum came out. There was transient relief, but none of the patients recovered.

II.

That we have so few facts to help us, shows that the ligature has not yet come to be used for hæmorrhages from the lung; and Glück's hopes of it have still to be realized. He is no less at fault, rather more, as to the surgical treatment of new growths of the lung; operation for their removal is the exception, not the rule; and since the time when one surgeon put an end to his life, having lost a patient immediately after operation for removal of the apices of the lungs, the number of resections, in spite of one or two very remarkable cases, has remained so small that one can hardly take them seriously.

Resection of lung-tissue has been practised for the removal either of tubercular masses, or of nodules of cancer, usually

the former. The four cases quoted by Truc all ended fatally within a fortnight of the operation. On the other hand my colleague, M. Tuffier, has recorded a brilliantly successful case, and Mr. Lowson has done the same. But these two successes, which reflect so much honour on the skill of those who won them, do they change the impression that we have got from the failures? No, they do not; resection of the lung for tubercular disease seems to me condemned past appeal. Either the disease is diffused through one or more lobes, and then the attempt is too dangerous, the patient is too weak and ill to stand such mutilation; or it is of slight extent, limited to one apex, as in Tuffier's case, and then one may hope that medical treatment will get the better of it at less risk to the patient. This argument is so unanswerable, that Mr. Lowson's operation, in spite of its splendid success, seems to have closed the list of resections for tubercular disease.

Cases of resection for cancer are still more rare. Everybody quotes the case published by Dr. Anthony Milton, of Georgia, who says that he removed the fifth and sixth ribs which were *carious*, and two-thirds of one of the lobes of the right lung; the patient lived four months after the operation. But was it really cancer? The cases of Krönlein, Müller and Weinlechner are more to the point.

And I would call your attention to a case published by Demons, in 1886, of resection of a hernia of the lung, which issued through a wound of the chest-wall between the ninth and tenth ribs. The swelling was half the size of one's fist; on the first day it was pink, polished, and soft, yet nc attempt was made to reduce it; next day, it was congested; and after eight days, when it was irreducible, and already gangrenous, it was removed with an écraseur, and the wound healed. But this operation might have been avoided, if the surgeon had reduced the hernia early while it was still soft and pliable; or, having left it eight days, he might have left it altogether, for the gangrenous portion would have come away, and the stump would have healed rapidly. We need hardly give the title of resection to this very modest proceeding.

Such to the best of my knowledge is a fair statement of the case for resection; we need not give this title to the removal of the sloughs in gangrene, for here no healthy tissue is incised. What conclusions are we to draw from these observations? In certain exceptional cases of extension of a growth from the chest-wall to the lung, the

resection of the diseased parts of the lung may be defended, though in the majority of these cases it is best to abstain from operation; but resection for primary cancer is condemned past appeal. With König, Peyrot, and Forgue, we say that it is impossible to do such an operation without first setting at defiance the essential facts of pathology. Either the disease is a small isolated growth, and then there is no sign of its presence, or it is large, diffuse, and multiple, and then to remove it is sheer homicide. In spite of Glück there is no reason in resecting the human lung, or in arguing from rabbits to men.

III.

Our third group of lesions that are within the reach of surgery includes the cavities, with walls, more or less well-defined, and filled with stagnant débris of secretions of all kinds. These morbid conditions that may need incision are many in number, and we must take into consideration tubercular cavities, bronchiectasis, gangrene, abscess, and hydatid cysts. Here there is less risk in interfering, and Glück's aphorism—"ubi pus ibi incisio"—may, I believe, be admitted almost without reserve. And here too we have more material to decide upon: there is a good collection of memoirs and lists of cases, and the conclusions drawn from all this wealth of careful work seem to deserve that we should loyally accept them; and in particular I would mention the observations published by Fabricant[1] in 1894, which have been of great use to me in preparing this report.

A.—Tubercular Cavities.

I shall take tubercular cavities and dilatation of the bronchi together—not because they have often been mistaken one for another, for we may now avoid this by a bacteriological examination, but because the indications for operation are almost exactly the same in the two diseases. In spite of our first enthusiasm, we must interfere only in exceptiona cases; and even if the cavity or the troubles that come of it can be improved by incision, the original cause of them, the tubercular disease itself, is still left behind, past all help from incision. So it is also with dilatation of the bronchi: it is not a single bronchus that is at fault; in most cases the number of them is very large, and the surgeon

[1] "Moniteur Chirurgical," St. Petersburg, 1894.

cannot lay them all open. In both these conditions, when the patient has got over the dangers of operation—always serious for those who are broken in health—and when he ought to be enjoying the advantages of having his cavity drained, the original disease still goes on, and if incision has not hastened death, it has at most only delayed it. For this reason the passion for operating is now almost gone, and there is a daily increase in the number of those physicians who forbid the opening of these cavities, at all events as a usual treatment.

Taüfert, Bull, Krecke, Runeberg, Park and de Cérenville, are very clear on this point; the last of them gives us a list of 6 cases after operation, five of whom died, and the sixth was thought not likely to recover. Again, the operation itself is not free from danger. Taüfert and Werth show that of 100 cases 5 die directly from the operation, 70 live only a fortnight after it, and 15 less than a month. This leaves only 10 to be really the better for the treatment, to say nothing of any hope of permanent recovery. Hæmorrhage and, above all, pneumothorax, are the commonest causes of death.

Since 1885, the date of Truc's thesis, I have collected 8 cases by different surgeons of incision for tubercular cavity. If we were to pin our faith on them alone, this method would seem to give excellent results; for they give 6 cures, or improvements, and only 2 deaths, one with signs of gangrene of the lung, and one from sudden profuse hæmoptysis. But over and above the fact that they were cases specially suited for operation, I fear that surgeons have published their successes rather than their failures. My figures therefore do not in the least influence the opinion that I have already expressed.

B.—Bronchiectasis.

Incision has not given good results in this disease. You open a cavity full of accumulated secretions, and you feel confident that as drainage goes on, and the cavity slowly gets smaller, your patient will improve; and then the signs of septic absorption begin all over again, because there are multiple dilatations burrowing elsewhere in the lung. This is what happened in the cases recorded by Bull and Biss: the *post mortem* examinations showed that beside the cavities that had been incised there were many others of various sizes. I have the same story to tell of a case of my

own: I resected a piece of the third rib, exposed the lung, and made my way through two inches of toughened lung tissue, and got into a cavity large enough to admit one's fist, and let out an enormous quantity of unhealthy pus. The patient got over the operation, put on flesh for a month, then began to waste again. As the drainage had failed to bring about the falling-in and cicatrization of the cavity, I resected the ribs over it. The patient died, and the *post mortem* examination showed the presence of other cavities. Still, in the course of the last ten years I find five instances of operation, and in every case the patient was cured or improved; but we must make the same reservations here as in cases of tubercular cavities: almost all the cases have been specially favourable for operation, and there has been a general tendency to publish successes, not failures.

Are we then to forbid incision of the lung in every case of tubercular cavity or bronchiectasis? No, but it seems to me that the indications for operation are present in only a few cases; and so I get back to the rules that Truc laid down ten years ago—"When the cavity in the lung is the essential lesion; when the symptoms of septic absorption dominate the scene; when there is high fever, and the patient is shaken by cough, and exhausted by profuse expectoration, then, without raising vain hopes, and simply to alleviate his suffering, we may have recourse to incision of the lung. Now and again a marked improvement has been noted."

Lavenstel has recorded a case where he incised and drained a cavity in the upper lobe of the right lung. The patient ceased to be feverish, he regained strength, and was able to do hard work. Unhappily two years later he died of uncontrollable hæmorrhage.

C.—Hydatid Cysts.

With this disease we begin the list of those morbid conditions of the lung for which incision is really efficient: it is the ideal method. Left to itself the cyst may indeed become obliterated: there are plenty of observations to prove this; but this happy ending is purely a matter of chance, and Neisser's statistics tell that of 61 patients thus left to themselves, 15 recovered, and 36 died. Davaine says much the same of the evils of this expectant treatment: according to him two-thirds of the cases die. Hearn in 1875 collected most of the instances recorded up to that date, and came to the same conclusion. To hold one's hand

on principle, when one is dealing with a hydatid of a lung, is thus simply to court death.

Since 1873 incision for this disease has been done so often, that we can judge of the value of it. There are the figures given by Thomas (5 cases of his own, and 27 others); 32 cases with only 5 deaths, and 27 cures. Lopez, of Lisbon, brought the list up to 36 cases, still with only 5 deaths; and my own table of more recent records shows that the proportion of successes has been kept up. We may admit that the successful operations are more readily published than the unsuccessful, still the immense value of incision for this disease is beyond the possibility of dispute.

Indeed, what method could we propose instead of it? Simple puncture is hardly more useful than the expectant treatment. Out of 16 cases thus treated, collected by Maydl, 11 died, either from purulent pleurisy, or from pneumothorax, or actually from sudden suffocation, due to the cyst bursting into the bronchi. In Thomas' statistics the expectant treatment gives a mortality of 54 per cent., puncture gives 27, incision 16 only. There is no room for doubt in this matter. We must decide with Heidenreich, Maydl, Mackenzie, Peyrot, Forgue, and I may say with the whole body of surgeons, whose opinion is worth anything, that incision is the only right method. My own statistics (1885-1895) give 11 operations, with 9 cures, and only 2 deaths. Success has not always come at once, and in several of the cases there has been a tedious broncho-pulmonary fistula. One of the deaths was due to suffocation from passage of the daughter cysts into the bronchi.

D.—Gangrene of the Lung.

In gangrene of the lung, the good done by incision is, at the lowest estimate, as great as in hydatid cyst, and if the absolute number of successful operations is not so large, we must remember that the disease itself is much more dangerous. In cases left without operation, the mortality is from 55 to 65 per cent. for hydatid cyst, but 75 per cent. for gangrene, so far as we can judge from statistics; and if we put together the cases collected by Lebert, Hutchinson, and Bonome, we find that of 71 cases of gangrene left to themselves, 54 died.

And what do we learn from the record of cases treated by incision. In Truc's thesis we find 13 operations (1879-1884), with 7 cures and only 6 deaths, bringing down the mortality

from 75 to 50 per cent. Richerolle's figures are somewhat better even than these: in his thesis (1892) he gives 31 operations, with 17 cures or improvements against 14 deaths. Finally, if we take Fabricant's list, which seems to me very carefully worked out, we get 26 operations, with 16 cures and 10 deaths, a mortality below 50 per cent. Taüfert, in 10 operations, gives 7 cures, and 3 deaths.

Our results will be still better when we operate earlier. The patient is admitted under the physician, and too often we vainly trust to nature, and to inefficient treatment, and forget the surgeon, or invoke his aid as a last desperate resource. There are plenty of operations that failed only because they were done too late. In some of the cases that I have tabulated, the poison had time to sow the seeds of metastatic abscesses in the viscera; in others the gangrene, at first circumscribed, suddenly becomes diffuse; in others, the patient is so enfeebled that he cannot stand the shock of operation. Most of them might have been saved by a ready diagnosis, and an early appeal to surgery.

The prognosis chiefly depends on the choice of the right time for the intervention of surgery, but not on this alone. Women, who are less often attacked by the disease, do not stand the operation so well as men. Old people are bad subjects for it; and Fabricant has noted that, in cases already exhausted before operation, only the young pull through after it: the results in those who are over 40 years old are bad.[1]

Not every case of gangrene of the lung is fit for incision, and we must start by defining what can, and what can not, be done by the surgeon. First, the disease must be circumscribed. A case of diffuse gangrene is altogether beyond operation. Next, the gangrenous cavity may be circumscribed, and yet incision may not be necessary. When the patch of disease is small, and the general condition of the patient is good, when there are no signs of approaching septicæmia, and above all, when the patient is young, the surgeon must hold his hand. But under other conditions, when the cavity is well defined, and of large size, when it

[1] In 15 cases of incision, where he was able to ascertain the cause of the gangrene, the results were as follows: 6 after acute fibrinous pneumonia, 4 cured; 4 after purulent bronchitis, 2 cured, 2 relieved; 1 after inflammation of mastoid, cured. But 2 from foreign body in the air-passages, and 2 from bronchiectasis, all died.

cannot empty itself, and the putrid sloughs are beginning their poisonous work, then we must carefully ascertain the exact seat of the disease, and operate without delay.

Truc lays down two conditions as necessary before operation: the site of the disease must be favourable for interference, and there must be adhesions over it. Of course it is not a matter of indifference whether the cavity is superficial or deep, and whether the pleura is shut off or open; if the cavity lie just beneath the surface of the lung, beneath dense adhesions, we shall have a very much better chance with it. But those that lie deep, even if the pleura be not obliterated by adhesions, are still not inaccessible; and Krause of Altona has published a case of this kind, where the operation was brilliantly successful. It was that of a man, aged 36, with gangrene of the lung after pneumonia. When the pleura was reached by resection of ribs and removal of intercostal muscles, it was found to be non-adherent; he therefore did the operation by two separate stages, in the way that I will describe later.

I have put together 13 cases of gangrene of the lung, all of them subsequent to Truc's work; and they give no less than 11 cures and only 2 deaths. One of these was a woman aged 34, who, only a fortnight previously, had undergone ovariotomy: she died a fortnight after the operation on the lung.

E.—Abscess of the Lung.

The value of incision is as far past doubt in this disease as in hydatid cyst or gangrene. We may admit that recovery without operation is possible. Apart from small circumscribed collections of pus, overlooked by the surgeon, and absorbed by nature, a larger cavity of a regular outline, without diverticula, may empty itself through a large opening into the air-passages, and thus be healed. But huge anfractuous basic cavities, ill-drained along narrow tracks in the lung, are far more dangerous things, as Frey has shown in his thesis (Paris, 1891). Slowly or fast these patients go down-hill, and die of septic absorption, or of sudden suffocation from the pus breaking into the bronchi. Death is so common, that we dare not hesitate, we must operate. And we find the claims of incision for these cases advocated long before the time of Lister; it was done successfully ages ago. There was Pouteau's patient (1753), the Abbé Proton, almoner of the great Hôtel-Dieu of Lyons: to say nothing

of Hippocrates. But most of these pioneers of surgery did the operation without knowing it. The patient was coughing and spitting pus; there was a hot, red swelling in the wall of the chest; the surgeon opened it as he would have opened a common abscess, and then discovered that he had incised a cavity of the lung. Later, when incision of the chest-wall became generally practised, the operation was still to some extent a matter of chance; the incision into the pleura just happened to relieve a diseased lung which had already infected the pleural cavity.

Anyhow, the operation for abscess of the lung got through its period of probation in the days before antiseptic surgery; thus it has been less criticised than other operations on the lung, and its record is a long one. I do not give Truc's figures, because he mixes together true abscesses and bronchial dilatations, and we know how much worse the prognosis is in these latter. Seitz gives 11 cases of abscess, with 8 cures or improvements, and 3 deaths; Lopez gives 14, with 1 death; Richerolle adds 16 cases to those of Seitz, giving a total of 27, with 19 cures or improvements, and 8 deaths. Finally, we have Fabricant's tables—38 cases, with 29 cures and 9 deaths: and we must remember that Taüfert records 5 operations, all successful.

Fabricant made an analysis of these cases, to find what circumstances influence the result of operation one way or the other. Men suffer more often than women, and recover more quickly, and the young fare better than the old. The nature of the primary disease plays a great part in determining the course of events: 17 cases of abscess after fibrinous pneumonia gave 14 cures and 3 deaths; 7 after specific fevers gave the following results: typhoid, 2 cases, both cured; scarlet fever, 1 case, which died; pyæmia, 4 cases, 3 cures, 1 death. Suppurating hydatid cyst, 3 cases, all cured; bullet-wound, 2 cases, both cured. Pneumonia is therefore the commonest cause of abscess of the lung, and operation on abscesses of this character is, in the great majority of instances, crowned with success.

We know that the indications for any operation increase as it becomes more hopeful and more helpful; and incision for abscess of the lung is not in itself dangerous, and gives excellent results. Thus we have become more ready to operate since Truc's work was published, and may now assert that wherever there is an abscess there ought to be an operation. No need to wait till fever blazes up, till the

patient is threatened with septic absorption, and his general condition is alarming; one has no right to delay, save perhaps in a case where the abscess is very small, draining easily and readily into the air-passages; or where there are multiple abscesses, requiring for their evacuation such mangling of the chest as would not be justified. Happily these latter cases are rare.

'There is one indication against operation,' says Truc, 'which holds good absolutely, and in every case, and that is the absence of adhesions over the abscess: it is rare not to find them, but they may be absent if the suppuration is rapid, or in the depths of the lung. If they are absent, your incision would bring about a frightful pyo-pneumothorax.' I have to say of this what I said of incising gangrenous cavities: an abscess may lie deep in the lung, the two layers of the pleura may glide freely one over the other, and yet it may be your duty to incise the lung, taking certain precautions—probably the best thing is to do the operation by two distinct stages. I do not admit the absolute authority of Truc's rule, though it is supported by some very eminent surgeons.

My figures for the last ten years (1885-1895) give 23 operations, with 20 cures and 3 deaths. Of these 3 deaths, one was from a huge cavity of the whole of the base of the lung; the second was from septicæmia two months after operation; the third was also from septic absorption.

I must just mention some other conditions of the lung that may come in need of the surgeon. We need hardly stop to consider foreign bodies in the lung, which have entered it through the chest-wall, or from the upper air-passages. Either they become encysted, and there is nothing to be gained by operation, or they cause suppuration in the lung, and then come into a group of cases already described. Fowler's patient, with a loose tooth in his air-passages, has become a classical case. I have given Moorhof's case in my tables—penetrating gun-shot wound of the chest, fragments of rib carried in with the bullet, suppuration, incision of lung, death.

Richerolle, in his thesis, gives a special chapter to actinomycosis; but this disease is so very rare in France that I need not delay over it. Either it is so widely diffused that no operation is possible, or it is circumscribed, and then its treatment is the same as that of abscess. I know no instance of operation for this disease of the lung.

Hernia of the lung from injury I have already considered;

the 'spontaneous' form of this displacement may need operation, if the welling has a tendency to grow larger, and causes distress, and prevents the patient from working. Thus, in Tuffier's case, the hernia, long inactive, became so troublesome and so painful on exertion, that the man could not follow his trade. Tuffier made an incision, exposing the swelling, and reduced it; he then cut away the pleural sac, and refreshed and sutured the ring. Three months later, there was no sign of relapse.

Finally, we must note Guermonprez's curious case, where he resected pieces of six ribs to get at a broncho-pulmonary fistula, an inch and a half long, and sutured it with catgut: the patient slowly made a complete recovery.

IV.

The rules of surgical technique, says Truc, need never trouble the surgeon; and he is quite right. I shall not describe the various methods practicable against hæmorrhage in wounds, resections and incisions of the lung; and as for the wounds and the resections, what is there to say? The surgeon is taking his chance of what he will find, and his procedure will be according to the exigencies of the case. I will only say that if he has to deal with a wound of the lung, he must make his opening into the chest-wall very free, or he will never find the bleeding vessels. Delorme's 'temporary resection' does this for us, but such heroic treatment is full of danger when the patient is wounded, feeble, and drained of blood. And the surgeon will have to steer between Scylla and Charybdis, neither to be too sparing with his incisions, lest he fail to find the source of the hæmorrhage, nor to cut too freely lest the patient come in danger of death from shock. In the same way, there are no definite rules of procedure for the removal of a portion of the lung. What is there in common between Tuffier's delicate manœuvres in resection of the apex for tubercular phthisis, and the removal of a mass of lung tissue protruding through a wound of the chest-wall, or the eradication of a track of malignant disease extending from the chest-wall to the lung? The surgeon must do the best that he can, suiting his methods to his patient's needs. But incision of the lung may now be reduced to certain definite rules of procedure. The skin-incision may be U, or H, or T-shaped as the surgeon prefers it; anyhow it must give unhindered access to the ribs. You must have plenty of room, a right of way to the cavity, and

an opening into it large enough to let you cleanse it quickly and thoroughly. What is more, it might easily fail to close if the chest-wall, after resection, did not allow the gap to become obliterated by apposition of its walls. You really do a sort of Estlander's operation to ensure this.

Again, as Krause has pointed out, you must be able to have a good look at the pleura, to see if it is, or is not, adherent. This matter is so important that the absence of adhesions has long been held absolutely to forbid incision of the lung. It is certain that if the cavity of the pleura is unclosed, the septic contents of the lung cavity, set free by incision, may find their way into it, and start a fatal pyo-pneumothorax. Therefore, to know if adhesions are present, we must follow Krause's plan, make a sufficient resection of several ribs, remove the intercostal muscles, and expose the pleura without opening it. If it is thin, soft, and transparent, and if one sees through it the lung, rising and falling in respiration, then the two layers are not adherent, the pleural cavity is not obliterated ; but if it is thick, tough, and whitish, probably it is adherent, and we can assure ourselves on this point by thrusting a needle into the lung. If the needle remains steady, not oscillating with the movements of respiration, then we may proceed ; there is no pleural cavity, no fear of pneumothorax.

In those cases, happily exceptional, where the cavity in the lung has not, by inflammation, brought about this coalescence of the layers of the pleura, must we give up the hope of incising the lung ? Truc says pretty plainly that we must, but I have already quoted Krause's case, where operation was successful in spite of this difficulty. Several ways of meeting it have been proposed. The safest is operation in two stages, as Volckmann proposes for hydatid cyst of the liver. Having reached the pleura you open it, very carefully, for fear of the lung collapsing—and if it give signs of collapse (or even, to avoid this, before you open the pleura), you must suture the two layers together round the area where your pleural incision has been, or will be made—then you cover the pleura with sterilized iodoform gauze and leave it for 5 days at least, if not more. By that time you have adhesions strong enough to let you open the cavity without fear of infecting the pleura. This is the best method, and vastly preferable to the use of caustics.

But if the patient is in imminent danger, and you must open the cavity at once, then it is necessary to incise the pleura, take hold of the lung, and fix it in the wound,

uniting the two layers of the pleura either by interrupted sutures set close together, or by Roux's continuous suture à arrière point. I need not go into the details of this method. It is so well known and so often practised for hydatid cysts of the liver, that every surgeon will know how to employ it for incision of the lung. And these central suppurations in the lung, with no inflammation in their neighbourhood, and no alteration of the pleura, and no adhesions, are not so rare as one might suppose. In two of the cases collected by Fabricant, the contents of the cavity made their way between the two layers of the pleura, and set up fatal inflammation of it. In two other cases there was the same absence of limiting adhesions, so that incision of the cavity was followed in one case by empyema, and in another by pyo-pneumothorax. which involved another operation. Roux, to avoid these disasters, sutured the two layers of the pleura together before opening a cavity in the apex of the right lung.

Once the adhesions are there, whether they be the work of Nature or of Art, the next thing is to open the cavity. You once more assure yourself, by means of an exploring needle, that you are going right for it; you leave the needle *in situ*, and thus have it to guide you into the cavity. The best way to open it is with Paquelin's cautery, just heated to a faint dull red. This seals the smallest vessels as it divides them, and thus you avoid the flow of blood, so dangerous to those who are enfeebled by disease. It was this bleeding that proved fatal in one of the cases in Fabricant's collection, and gave great trouble in three others. You should only use the knife if the layer of lung-tissue over the cavity is thin and toughened, and even then it is best not to trust to it.

Once you have opened the cavity, you put in your finger and dilate the opening. If any secondary cavities open into the first one, you break down the septa between them with your finger nail: but you must only do this with the greatest caution, and must respect any strands or bridles of tissue traversing the cavity, lest you tear open some vessel.

The exploratory puncture often fails; if it does, is one bound to give up incision of the lung? No, you must still incise the toughened lung-tissue, and even if you fail to find pus, your operation will nevertheless do good. The cavity, nearly but not quite opened, will ulcerate or break through its wall more easily at this point of least resistance. There are plenty of observations to show this. M. Groube's case is a remarkable instance of this. It was not till five days after incision of the lung that the dressings, which

had been dry all this time, were soaked with an enormous quantity of pus, and the expectoration was proportionately diminished. In James' case the pus escaped three hours after the operation; in Krimer's, two hours; in Kunberg's, two days; in Cayley and Gould's, several days. Finally, Quincke gives a case where he made a way with the cautery into the thickness of the lung, and the pus did not find exit through this opening till twenty-three days later, during a violent fit of coughing.

Once you have opened the cavity you must drain it carefully. You have resected the rib freely enough to make a large opening in the chest-wall, and the fluid and fœtid débris will have no difficulty in getting out. Still, cases have been recorded where the surgeon had to make a counter-opening, and to drain the lung right through. To ensure good drainage, use a soft rubber-tube, together with strips of iodoform gauze. This method has stood trial well, and most surgeons seem to have adopted it.

Ought we to irrigate the cavity? No, emphatically, not even very gently. A better plan is to wipe its walls with pledgets of absorbent wool, and to do even this cautiously, lest one should lay open any vessel. Fabricant says that four of his collected cases show definite bad results from irrigation. In one of them the use of a lotion containing boric acid and thymol set up fatal inflammation of the air-passages.

Conclusions.

1. The surgery of the lung does not, as Glück said it did, follow that rule of general surgery 'Ubi hæmorrhagia ibi ligatura, ubi tumor ibi extirpatio, ubi pus ibi incisio.' The structure of the lung and its air-passages, the part it plays in sustaining the life of the blood, its relations with the heart, and the presence of a pleural cavity, all forbid great expectations, and limit the power of the surgeon.

2. Resection, incomplete or complete, of a part of the chest-wall, to reach a wound of the lung and stop a mortal hæmorrhage, as a last chance, is doubtless an ultimate measure that we must recognize as justifiable; but it is dangerous, and not yet sanctioned by experience.

3. Resection of tuberculous masses ought to be proscribed. If the disease be advanced or diffused the mutilation necessary for its removal would be beyond the patient's strength. If the infective nodule be circumscribed, general

treatment will deal with it as efficiently as an operation, and without its risks.

4. Resection of a part of the lung for primary malignant disease is not even worth discussing. An accessible, single, circumscribed growth would be a clinical wonder that would evade our present powers of observation. The utmost that the surgeon can do is, after the example of Krönlein, to follow even into the lung a sarcoma growing from the chest-wall: but this will never be more than one of the brilliant exceptions of surgery.

5. With pulmonary cavities surgical intervention is more precise, and more general. But incision for tuberculous cavities, and for bronchial dilatations, will very seldom be practised: for these conditions are almost always diffuse. In every such case the operation is only palliative.

6. Hydatid cysts, on the contrary, and gangrene, and abscess, can be vastly improved by incision. This is radical treatment in the true sense of the word, and many lives are saved by it. To speak too highly of incision in these cases is simply impossible, and the physicians who have the care of them ought never to forget the precious gifts offered to them by surgery.

7. The technique of the removal of lung-tissue varies so widely with the character of the tumour submitted to operation that one cannot define the rules of it. But the details of incision of the lung have been accurately settled. Free incision of the soft parts, adequate resection of the ribs, operation in two stages, or thorough suture of the two layers of the pleura, if they be not adherent, opening into the lung with the cautery at dull red heat, no irrigation, respectful avoidance of vessels whose rupture would cause hæmorrhage, drainage of the cavity with soft rubber tubes, and iodoform gauze.

APPENDIX B.

ON BULAU'S TREATMENT OF EMPYEMA BY CONTINUOUS SYPHON-DRAINAGE.

I GIVE here Dr. Bulau's own account of his method, and have added to it, in the form of a debate, abstracts of the favourable and unfavourable opinions of it that have been published[1] by other surgeons. The controversy is worth reading, on account of the way in which it sets forth some of the practical difficulties in the treatment of empyema.

'I worked out this method because I saw such lamentable results (permanent contraction of the lung) follow the admission of air into the pleura. I reasoned that, since the elastic force of retraction in the lung is to the pressure of the atmosphere only as 1 to 100, therefore a column of fluid, 30 to 33 inches high, would easily overcome it. That a lung, after long collapse, can still expand again if you lessen the pressure of the atmosphere on it, I learned from a case of fistula of 15 months' duration, where my method was successful. You incise the skin, puncture the chest with a trochar and cannula between a fourth and a fifth of an inch wide, slip a soft rubber catheter through the cannula, put a clip on it, fix it to the chest wall, connect it by a piece of glass tubing with a long piece of rubber tube filled with lotion, and lower the long tube into some lotion. If you leave a coil of the tube loose on the bed, the patient's movements in bed will not stir the catheter. The objection to my method—that it leaves masses of fibrin in the chest—is unreasonable. I admit that the catheter often gets blocked at first, but either you can put this right by going down the tube with your finger and thumb, or you can syringe lime-water up the tube, or in a day or two a fit of coughing will

[1] For references, not already given, see Bulau, "Ztschr. f. Klin. Med.," 1891, xviii., 31; Slajner, "Wien. Klin. Wchnschr," 1891, p. 229; Gläser, "Resectio Costarum," Hamburg, 1890, and "Ztschr. f. Klin. Med.," 1891, xviii., p. 481.

drive a lot of pus into the tube, and set it going again. If the patient keeps feverish, either there is suppuration round the puncture, or the tube is blocked; you had better wait and see what happens; for if you take out the catheter, you can hardly ever get it in again; you ought not to touch it for at least eight days. The catheter does not get nipped by the ribs, for with my method the chest does not fall in. If there is pain, the syphonage must be reduced, unless the pain be due to irritation of the pleura by the catheter. After some time, you may let the patient get about, keeping the lower end of the tube in a bottle hung below his chest; later still, you may cut off the tube, and just keep the end of the catheter in place till all is healed. There is no need to wash out the pleura. Even if the pus be offensive, my method will be applicable to the case; but a gangrenous empyema depends on gangrene of the lung, and therefore resection is necessary.'

DR. IMMERMANN (Basel): 'I consider that the modern operations for empyema are too severe, and that Dr. Bulau's method is the best possible treatment of empyema; it cannot set up pneumothorax, and it maintains negative pressure within the pleura. If the tube gets blocked, you can apply suction to the end of it, or syringe up it, and so drive the masses of fibrin back into the pleura; they will, in time, break up and be absorbed. In three or four weeks (the patient may have been walking about for some time with a portable apparatus) you take out the tube, if the discharge has ceased. But of course this method is only valuable if the lung can still expand. It is not suited for cases of pyo-pneumothorax, or advanced phthisis, or very chronic empyema, or for gangrenous empyema, though I did cure one case of this kind with it. It is excellent for large, simple, ordinary, recent empyema, and for double empyema. In cases following pneumonia, there is one drawback, that the pus is often very tenacious, and the adhesions very extensive.'

DR. SLAJNER (Graz): 'I have observed eighteen cases of empyema treated by this method, with very good results. That some of the cases ended in death from tubercular or amyloid disease is no argument against it. In six of my cases, there was already a fistulous sinus; all of them were cured; and it is certain that this method can, in a relatively short period, cure cases of this kind. In three of the six, the ribs were so close together, and the sinuses ran such a tortuous and difficult course, that it was necessary to resect a small piece of rib.'

PROF. HOFMOKL (Vienna): 'I consider this method both inconvenient and unnecessary. Either the air gets into the pleura while the patient is coughing hard, and you are trying to dislodge masses of fibrin blocking the tube, or sooner or later the precautions against admitting air break down. I have often seen empyema patients getting about in great discomfort, believing the apparatus was air-tight, when at every cough you could hear the air whistling in and out of the pleura alongside the catheter. A little fluid, now and then, oozes into the bottle, to their great satisfaction, but most of it goes into the dressings. Dr. Bulau's method is worst of all in cases of tuberculous or gangrenous empyema.'

PROF. PEL (Amsterdam): 'I have often tried this method, but have now given it up altogether; I had two cases where it succeeded, and then had a number of failures. It does not get rid of the masses of fibrin; it is difficult, if the intercostal spaces are narrowed; and it sometimes causes pain and bleeding inside the chest.'

PROF. SCHEDE (Hamburg): 'This method is admirable in theory, but not always easy in practice. That it often fails, is shown by Prof. Gläser, whose 22 cases of resection and free incision, with only one death, and that from amyloid disease, include 5 cases, where Dr. Bulau's method had been tried and had failed. But it is to be noted, in its favour, that Dr. Simmonds had 8 continuous successful cases with it; in the ninth case, the tube continually became blocked, and a free incision had to be made. All these nine cases were children. It is absurd to use this method in cases of gangrenous empyema. I had one case where it answered admirably—a woman, aged 29, with a small empyema on the left side; (a year before, she had suffered total putrid pyo-pneumothorax of the right side, cured by free resection and incision). The catheter slipped out on the third day; but the fluid did not re-collect, and she healed rapidly. And it is a most excellent method for cases of double empyema. But the working of it is easily thrown out of order by blocking of the tube, or by sudden movement of the patient; it is altogether too elaborate. Think what a problem it presents; you have to keep at rest, night and day, a restless, perhaps delirious, sick child, till everything is healed up, or to watch incessantly a feverish, sleepless patient, that no chance turn of his body, or pull on the tube, may in a moment spoil all your work.'

DR. GLAESER (Hamburg): 'There is not a word to be said in favour of this method. You learn nothing as to the condition of things inside the chest. You have no idea where the

end of the catheter has gone; instead of relieving the lung at once, you leave it still compressed, especially if your tube gets squeezed by the dressings. Out of 8 cases, where I did resection and free incision after Dr. Bulau's method had failed, in one the pus was fœtid, in two the catheter was taken out and could not be put back, in three it was always getting blocked, in two rigors and fever occurred in spite of it. Dr. Bulau's method is tedious, dangerous, and useless. You can never get a mass of fibrin through a long narrow tube, and why should we leave these masses as hot-beds of infection inside the chest? In Schede's first series, of 12 cases, four had large masses of fibrin; in my 21 cases, five had large masses (one of them was of enormous size) to say nothing of smaller ones. Even if the method does succeed, it is terribly slow.'

The weight of opinion seems to me against this method, and I do not think it has been received with much favour in England.

INDEX.

JOHN WRIGHT AND CO.,
PRINTERS AND PUBLISHERS, BRISTOL.

NAME	DATE DUE
J. L. Jacobs	APR 4 1950
C Geraci	JUN -3 1946
E. Zaniroli, Ft. Miley	FEB 12 1954
Kamedl	NOV 2 [illegible]
Cowell	DEC 15 1962